CAL LAB

INSTRUCTION MANUAL
OSCILLOSCOPE
MODEL COS6150

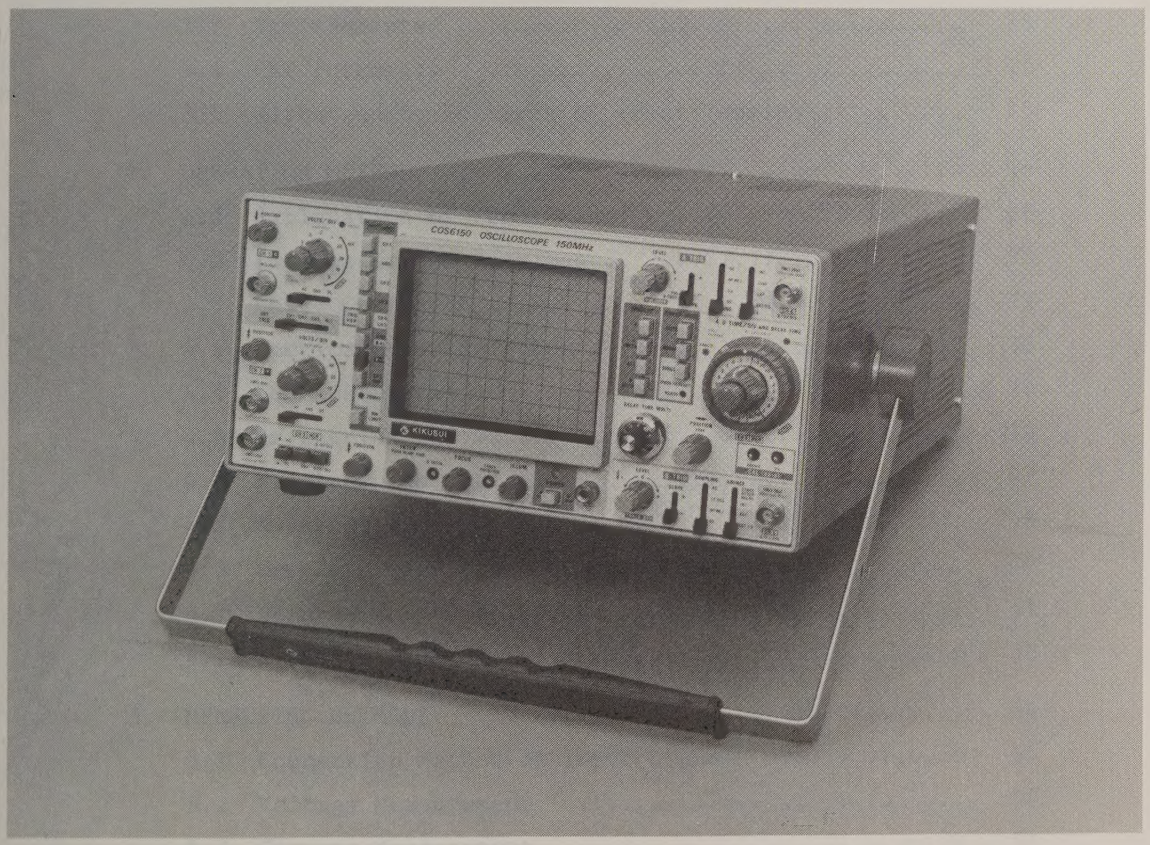
COS6150/PB

Kikusui
INTERNATIONAL CORP.

INSTRUCTION MANUAL

OSCILLOSCOPE

MODEL COS6150



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1. GENERAL

1.1 Description

Kikusui Model COS6150 Oscilloscope is a universal-type portable oscilloscope which is capable of 5-channel 12-trace display. It employs a 6-inch rectangular type cathode-ray tube with red internal graticule.

The COS6150 oscilloscope is sturdy, easy to operate, and extremely reliable. This scope has many convenient features and special functions which make it an ideal instrument for diversified types of research and development of electronic equipment. It can also be efficiently used in production line maintenance and service applications.

1.2 Features

The features of the COS6150 Oscilloscope can be summarized as follows:

(1) Ease of use:

Light torque lever switches and pushbutton switches are used. These and other controls are laid out in the most convenient locations making the oscilloscope extremely easy to operate.

(2) Clear waveform observation:

The cathode-ray tube is a 6-inch large-screen rectangular type CRT with a red internal graticule of 80 mm × 100 mm (3.15 in. × 3.94 in.) The red graticule produces a high resolution background for easy waveform viewing.

(3) High acceleration voltage (20 kV):

The high acceleration voltage of the CRT ensures a bright trace for observation and photography.

(4) High sensitivity and wide frequency bandwidth:

The maximum vertical sensitivity is 1 mV/DIV (with ×5 MAG) and the frequency response is 150 MHz or greater (-3 dB).

(5) High input impedance:

The input impedance of CH1, CH2, CH3, CH4 and CH5 (EXT TRIG) is 1 MΩ ±1%, 20 pF ±2 pF, allowing the use of 10× Probes.

(6) 5-channel simultaneous display:

The COS6150 employs a new type of vertical mode switching circuit which enables display of any combination of CH1, ADD (CH1 ± CH2), CH2, CH3, and TRIG VIEW (CH4 and CH5). Up to five channels can be displayed simultaneously; up to twelve traces can be displayed when in the alternate sweep mode.

(7) Trigger level lock:

A new trigger level lock circuit eliminates the requirement of triggering adjustments on most signals. (Manual control is still available for triggering on complex waveforms.)

(8) Stable alternate triggering function:

When in the alternate triggering mode, stable triggering can be attained even when the signals of CH1, CH2 and CH3 are not time releated. (patent pending)

(9) TV sync triggering:

The COS6150 has a sync separator circuit, which allows triggering for TV V signal and TV H signal. It is automatically switched with the TIME/DIV control.

(10) B END'S A switch separated from holdoff control knob:

The B END'S A switch is installed separately from the holdoff control switch. Holdoff control can be used while in the B END'S A mode.

(11) Maximum sweep time 2 nsec/DIV with ×10 MAG function:

With the ×10 MAG function, the highest sweep speed of 20 nsec/DIV can be multiplied by a factor of 10 to attain a maximum sweep speed of 2 nsec/DIV.

(12) Alternate sweep:

The A sweep and the delayed sweep can be viewed simultaneously in the alternate mode.

(13) Linear focus:

Once the beam focus is adjusted, it is automatically maintained in this state regardless of changes in intensity.

(14) Multiple-channel X-Y operation:

By using the CH3 HOR channel as the X-axis input and all other channels as the Y-axis inputs, up to four channels of X-Y operation can be viewed.

2. SPECIFICATIONS

Vertical axes

Item	Specification	Remarks
CH1 and CH2		
Sensitivity	5 mV/DIV - 10 V/DIV 1 mV/DIV - 2 V/DIV (when ×5 MAG)	1-2-5 sequence, 11 ranges
Sensitivity accuracy	±2% ±4% (when ×5 MAG)	10 to 35°C (50 to 95°F), at 4,5 DIV
Variable vertical sensitivity	To 1/2.5 or less of panel-indicated value	
Frequency bandwidth	DC - 150 MHz (-3 dB) DC - 10 MHz (-3 dB), when ×5 MAG AC coupling: Low limit frequency 10 Hz	With reference to 50 kHz, 8 DIV. Except when in bandwidth limit mode (5 mV/DIV 10 - 30°C (50 - 86°F))
Input coupling	AC, DC, GND	
Input impedance	1 MΩ ±1%, 20 pF ±2 pF	
Allowable input voltage	400 V (DC + AC peak)	Frequency 1 kHz or lower
Square wave characteristics	Overshoot: Not greater than 3% (at 20 mV/DIV range) Other distortions: Not greater than 2%	Other ranges: Add 5% VARIABLE knob is CAL'D position. (5 mV/DIV 10 - 30°C (50 - 86°F))
CH3 (HOR)		
Sensitivity	0.1 V, 0.5 V/DIV	
Sensitivity accuracy	±3%	10 to 35°C (50 to 95°F)

Item	Specification	Remarks
Frequency bandwidth	DC - 150 MHz (-3 dB) AC coupling: Low limit frequency 10 Hz	With reference to 50 kHz, 8 DIV
Input coupling	AC, DC, GND	
Input impedance	1 MΩ ±1%, 20pF ±2 pF	
Allowable input voltage	400 V (DC + AC peak)	Frequency 1 kHz or lower
Square wave characteristics	Overshoot: Not greater than 8% Other distortions: Not greater than 3%	
CH4 and CH5	CH4: A TRIG EXT input CH5: B TRIG EXT input	
Sensitivity	0.1 V, 0.5 V/DIV	
Sensitivity accuracy	±3%	10 - 35°C (50 - 95°F)
Frequency bandwidth	DC - 100 MHz (-3 dB) AC coupling: Low limit frequency 10 Hz	With reference to 50 kHz, 4 DIV
Input coupling	CH4: AC, HF REJ, TV, DC CH5: AC, HF REJ, LF REJ, DC	Selectable with the coupling switch
Input impedance	1 MΩ ±1%, 20 pF ±2 pF	
Allowable input voltage	100 V (DC + AC peak)	Frequency 1 kHz or lower
Square wave characteristics	Overshoot: Not greater than 10% Other distortions: Not greater than 5%	
Rise time	Approx. 2.3 nsec (Approx. 35 nsec when ×5 MAG)	CH1, CH2, CH3, 6DIV CH4, CH5, Approx. 3.5 ns 4DIV

Item	Specification	Remarks
Signal delay time	Approx. 30 nsec (with delay cable of approx. 90 nsec)	The displayed portion preceding the triggering point
Delay time differences among channels	Not greater than ±0.5 nsec among CH1, CH2, and CH3	
Polarity change	CH2 only	
DC balance shift	±0.5 DIV (±2.0 DIV when in ×5 MAG)	CH1 and CH2, at 10 mV/DIV
Display modes	Simultaneous displays of CH1, ADD (CH1 + CH2), CH2, CH3, and TRIG VIEW (CH4 and CH5) are possible in any combination. Single X-Y (CH1 for X-axis and CH2 for Y-axis) also is possible.	
Chopping repetition frequency	1 MHz/ (number of displayed channels) ±40%	
Common mode rejection ratio	50:1 or better at 50 kHz, sinusoidal wave	When sensitivities of CH1 and CH2 are set equal
Isolation between channels	At least 1000:1 at 50 kHz At least 30:1 at 100 MHz	At 5 mV/DIV range
Bandwidth limit	With filter for approx. 3 dB attenuation at 20 MHz	
Linearity	±0.1 DIV or less of amplitude ahange when waveform of 2 DIV at graticule center is moved vertically.	
CH1 signal output Output voltage	Approx. 10 mV per 1 DIV deflection amplitude on screen	50-ohm termination
Frequency bandwidth	DC - 100 MHz (-6 dB)	
Output resistance	Approx. 50 ohms	

Triggering

Item	Specification	Remarks
Internal trigger selection (INT TRIG switch)	CH1, CH2, CH3, ALT (When in ALT mode, a trigger source is selected depending on the vertical operation mode.)	When in ADD, the CH1 input signal is used as the trigger source signal.
A trigger		
Signal source	INT, LINE, EXT, EXT÷5	
Coupling	AC, HF REJ, TV, DC	
Polarity	+ or -	
Sensitivity	DC - 20 MHz: 0.4 DIV (0.04 V) 20 - 150 MHz: 1.5 DIV (0.15 V) Video signal: 1.0 DIV (0.1 V) AC coupling: Attenuates signal components of lower than 10 Hz. HF REJ: Attenuates signal components of higher than 50 kHz.	The values enclosed in the parentheses are the input sensitivities when in the EXT trigger mode.
B trigger		
Signal source	INT, EXT, EXT÷5	
Coupling	AC, HF REJ, LF REJ, DC	
Polarity	+ or -	
Sensitivity	DC - 20 MHz: 0.4 DIV (0.04 V) 20 - 150 MHz: 1.5 DIV (0.15 V)	The values enclosed in the parentheses are the input sensitivities when in the EXT trigger mode.

Item	Specification	Remarks
EXT trigger input	CH4 and CH5 input terminals used in common	
Input impedance	1 MΩ ±2%, 20 pF ±2 pF	
Maximum allowable input voltage	100 V (DC + AC peak)	Frequency 1 kHz or lower
AUTO mode	Satisfies the A trigger sensitivity specification for signal repetition frequency of 50 Hz of over.	
LEVEL LOCK	Satisfies the value of the above trigger sensitivity plus 0.5 DIV (0.05 V) for signal of duty cycle 20:80 and repetition frequency 50 Hz - 100 MHz.	

Horizontal axis

Item	Specification	Remarks
Horizontal axis display	A, A INT, ALT, B (DLY'D)	
A sweep		
Sweep mode	AUTO, NORM, SINGLE	
Sweep time	20 nsec/DIV - 0.5 sec/DIV 2 nsec/DIV - 50 msec/DIV (when in "× 10 MAG")	1-2-5 sequence, 23 ranges
Sweep time accuracy	±2%	10 to 30°C (50 to 95°F)
Variable sweep time	To 1/2.5 or slower of panel-indicated value	
Holdoff time	Continuously variable to 2 times or over of sweep length (time) at 20 nsec/DIV - 0.1 sec/DIV ranges	

Item	Specification	Remarks
B sweep		
Delay system	Continuous delay or triggered delay	
Sweep time	20 nsec/DIV - 0.5 sec/DIV 2 nsec/DIV - 50 msec/DIV (when in "×10 MAG")	1-2-5 sequence, 23 ranges
Sweep time accuracy	±2%	10 to 35°C (50 to 95°F)
Delay time	0.2 µsec - 5 sec	
Delay time accuracy	±2% of multidial-indicated value (except 0 - 0.50) ±3% of value read on screen	
Delay jitter	1/20,000 or less $\frac{\text{B sweep time}}{\text{A sweep time}} \times \frac{\text{jitter width}}{10\ \text{DIV}}$	Jitter width 0.5 DIV or less at A: 1 msec/DIV B: 1 µsec/DIV
Sweep magnification	10 times (maximum sweep time 2 nsec/DIV)	Both A and B
Magnified sweep time accuracy	0.1 µsec/DIV - 0.5 sec/DIV ranges: ±4% 20 nsec/DIV - 50 nsec/DIV ranges: ±5%	10 to 35°C (50 to 95°F)
Linearity	±3% ±5% (when in "×10 MAG")	
CH3 sweep (CH3 HOR)	CH3 input signal is used as sweep trigger signal. For vertical axes, any combination of CH1, ADD (CH1 + CH2), CH2, and TRIG VIEW can be simultaneously displayed in CHOP mode.	
Sensitivity	0.1 V, 0.5 V/DIV	Same as CH3
Sensitivity accuracy	±3%	Same as CH3

Item	Specification	Remarks
Frequency bandwidth	DC - 5 MHz (-3 dB) AC coupling: Low limit frequency 10 Hz	With reference to 50 kHz, 10 DIV
Phase difference between vertical axes	Not greater than 3° at DC - 100 kHz	
X-Y mode	X-axis: CH1 input signal Y-axis: CH2 input signal	
Sensitivity	5 mV - 10 V/DIV	Same as CH1
Sensitivity accuracy	±3% ±5% (when in "× 5 MAG")	10 to 35°C (50 to 95°F)
Frequency bandwidth	DC - 5 MHz (-3 dB) AC coupling: Low limit frequency 10 Hz	With reference to 50 kHz, 10 DIV
X-Y phase difference	Not greater than 3° at DC - 100 kHz	
Sweep signal output	A sweep signal	
Output voltage	Approx. 5 Vp-p	Zo ≒ 10 kΩ
Sweep gate output	A sweep gate signal	
Output voltage	Approx. 1 Vp-p	Zo ≒ 100 Ω

Z axis

Item	Specification	Remarks
Sensitivity	3 Vp-p (Trace becomes brighter with negative input.)	
Frequency bandwidth	DC - 10 MHz	
Input resistance	5 kΩ ±10%	
Allowable input voltage	50 V (DC + AC peak)	AC: 1 kHz or lower

Calibration voltage

Item	Specification	Remarks
Waveform	Positive-going square wave	
Frequency	1 kHz ±5%	
Duty ratio	Within 45:55	
Output voltage	2 V, 200 mV ±2%	
Rise time	Approx. 1 µsec	
Output resistance	2 V: Approx. 2 kΩ 200 mV: Approx. 200 Ω	

CRT

Item	Specification	Remarks
Type	6-inch rectangular type, internal graticule	
Fluorescent screen	P31 phosphor	
Acceleration voltage	Approx. 20 kV	
Effective screen size	8 × 10 DIV	1 DIV = 10 mm (0.39 in.)
Graticule	Internal graticule, continuously adjustable illumination	Red

Mechanical specifications

Item	Specification	Remarks
Dimensions of mainframe	310 W × 150 H × 400 D mm (12.20 W × 5.91 H × 15.75 D in.)	
Maximum dimensions	370 W × 200 H × 475 D mm (14.57 W × 7.87 H × 18.70 D in.)	
Weight	Approx. 9.5 kg (21 lbs)	

o Line power requirements

Voltage: 100 V, 115 V, 215 V, 230 V; with 10% allowance.
Selectable by connector change

Frequency: 50 Hz or 60 Hz

Wattage: Approx. 58 W (Approx. 70 VA)

o Operating environment

To satisfy specifications: 5 to 35°C (41 to 95°F), 85% RH

Maximum operating ranges: 0 to 40°C (32 to 104°F), 90% RH

o Accessories

P150-2 probes (10:1, 1.5 m).....	(89-03-0340)	2
942A terminal adaptors	(W4-986-011)	3
Slow blow fuse (0.5A)	(99-02-0001)	1
Slow blow fuse (1 A)	(99-02-0002)	1
Power cord	(85-10-0120)	1
Instruction manual	( )	1

Power cord (USA and Canada) ..... (85-10-0170)
(European countries) ..(85-10-0140)

3. PRECAUTIONS BEFORE OPERATING THE OSCILLOSCOPE

3.1 Unpacking the Oscilloscope

The oscilloscope is shipped from the factory fully inspected and tested. Upon receipt of the instrument, please unpack and inspect it for any damage which might have been sustained during transportation. If any sign of damage is found, please notify the bearer and/or the dealer.

3.2 Checking the Line Voltage

The oscilloscope can operate on any one of the line voltages shown in the below table. Insert the line voltage selector plug in the corresponding position on the rear panel. Before connecting the power plug to an AC line outlet, be sure to check that the voltage selector plug is set in the position corresponding to the correct line voltage. Note that the oscilloscope may not operate properly or may be damaged if it is connected to a wrong voltage AC line.

When line voltages are changed, replace fuses as required.

Selector plug position	Nominal voltage	Voltage tolerance	Fuse
A	100 V	90 - 110 V	1 A, slow blow
B	115 V	104 - 126 V	
C	215 V	194 - 236 V	0.5 A, slow blow
D	230 V	207 - 253 V	

3.3 Environments

The normal ambient temperature range of this instrument is 0 to 40°C (32 to 104°F). Operation of the instrument outside of this temperature range may cause damage to the circuits.

Do not use the instrument in a place where a strong magnectic or electric field exists. Such fields may disturb the measurement.

3.4 CRT Intensity

In order to prevent permanent damage to the CRT, do not make the CRT trace excessively bright or leave the spot stationary for an unreasonably long time.

3.5 Maximum Voltages of Input Terminals

The maximum voltages of the instrument input terminals and probe input terminals are as shown in the following table. Do not apply voltages higher than these limits.

Input terminal	Maximum allowable input voltage
CH1, CH2, CH3 inputs	400 V (DC + AC peak)
EXT TRIG (CH4, CH5) input	100 V (DC + AC peak)
Probe input	600 V (DC + AC peak)
Z AXIS input	50 V (DC + AC peak)

Note: AC Frequency is 1 kHz or below.

4. OPERATION METHOD

4.1 Explanation of Front Panel (See Figure 4-1.)

o CRT circuits:

POWER ..... (1) Main power switch of the instrument. When this switch is turned on, the LED (2) above the switch is also turned on.

INTEN ..... (7) Controls the brightness of the spot or trace.

(PUSH BEAM FIND) Even when the beam is outside of the screen, it can be located by pressing this beam finder button.

B INTEN ..... (6) Potentiometer for adjusting trace intensity when in B sweep mode.

FOCUS ..... (5) Focusing the trace to the sharpest image.

ILLUM ..... (3) Graticule illumination adjustment.

TRACE ROTATION ..... (4) Potentiometer for aligning the horizontal trace in parallel with graticule lines.

Bezel ..... (27) For installing a camera mount

Filter ..... (28) Blue filter for ease of waveform observation. Can be removed.

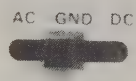
o Vertical axis:

CH1 (X) input ..... (21) Vertical input terminal of CH1. When in X-Y operation, X-axis input terminal.

CH2 (Y) input ..... (14) Vertical input terminal of CH2. When in X-Y operation, Y-axis input terminal.

CH3 (HOR) input ..... (12) Vertical input terminal for CH3. When TIME/DIV switch (39) is set in the [CH3|HOR] position, this terminal becomes the horizontal axis input terminal.

AC-GND-DC ..... (13) (20) Switch for selecting connection mode between input signal and vertical amplifier.

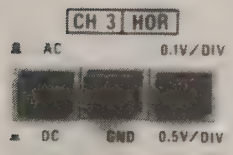


AC: AC coupling

GND: Vertical amplifier input is grounded and input terminals are disconnected.

DC: DC coupling

..... (9) (10) (11) Select input coup. .g and sensitivity of CH3.



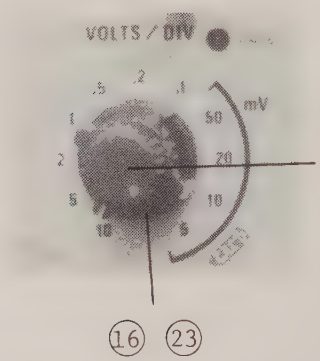
AC/DC: Selects coupling of input signal to CH3 amplifier between AC coupling and DC coupling.

GND: Grounds CH3 amplifier input signal and opens the input terminal.

0.1 V/0.5 V : Selects CH3 amplifier sensitivity between 0.1 V/DIV and 0.5 V/DIV.

VOLTS/DIV ..... (16) (23) Select the vertical axis sensitivity, from 5 mV/DIV to 10 V/DIV with 11 ranges.

VARIABLE ..... (15) (22) Fine adjustment of sensitivity, with a factor of 1/2,5 or over of panel-indicated value. When in the CAL'D position, sensitivity is calibrated to panel-indicated value. When not in the CAL'D position, the UNCAL lamp (18) or (25) turns on.



When this knob is pulled out, the amplifier sensitivity is multiplied by 5 times.

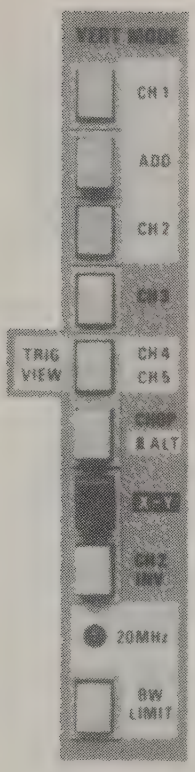
POSITION ..... (17) (24) Vertical positioning control of trace or spot.

When in X-Y operation, knob (24) is for horizontal positioning.

VERT MODE ..... (26) Select vertical axis operation modes and frequency bandwidth limit function. Any combination of CH1, ADD (CH1 + CH2), CH2, CH3 and TRIG VIEW can be simultaneously displayed. The functions of the buttons as they are depressed are as follows:

CH1: CH1 signal is displayed.

ADD: Sum signal (CH1 + CH2) is displayed.



CH2: CH2 signal is displayed.

CH3: CH3 signal is displayed.

TRIG VIEW (CH4, CH5): By depressing the TRIG VIEW button it is possible to look at either A TRIG VIEW (CH4) or B TRIG VIEW (CH5). Both TRIG VIEW A and TRIG VIEW B can be viewed at the same time if the B TRIG SOURCE switch is set in the INT or EXT (÷ 5) position.

CHOP ⎍ ALT: Selects switching mode when in multichannel operation.

⎍ : Alternate mode

⎓ : Chopping mode

X-Y: Oscilloscope operates as an X-Y scope, with CH1 for X-axis and CH2 for Y-axis. This button has the highest priority over all other buttons.

CH2 INT: Polarity of CH2 signal is inverted.

The up state is for normal polarity and the depressed state is for inverted polarity.

BW LIMIT: Limits the bandwidth of the vertical amplifier to approximately 20 MHz, cutting off the frequency components higher than this limit.

o Triggering

INT TRIG ..... (19)

Selects the internal trigger signal source. The signal selected by this switch is fed to the A trigger circuit if SOURCE switch (35) is set in the INT state or to the B trigger circuit if SOURCE switch (48) on rear panel is set in the INT state.

CH1: Input signal of CH1 is used as trigger signal.

CH2: Input signal of CH2 is used as trigger signal.

CH3: Input signal of CH3 is used as trigger signal.

ALT: Asynchronous signals on CH1, CH2 and CH3 may be viewed simultaneously using the INT TRIG ALT mode. (For details, see Subsection 4.6.)

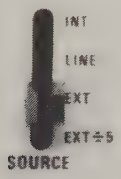
External trigger (CH4).. (36)
Input terminal

This terminal is used for both the CH4 input signal and the external trigger signal for the A trigger circuit. For the external trigger operation, set the SOURCE switch (33) in the EXT or the EXT ÷ 5 position.

External trigger (CH5) .. (46)
Input terminal

This terminal is used for both the CH5 input signal and the external trigger signal for the B trigger circuit. For the external trigger operation, set the SOURCE switch (48) in the EXT or the EXT ÷ 5 position.

SOURCE ..... (35)



This switch is used to select the trigger signal source for the A trigger circuit. The signal selected by this switch is used directly as the input signal of the TRIG VIEW (CH4).

INT: Internal signal selected by INT TRIG switch (19) is used as trigger signal.

LINE: AC line signal is used as trigger signal.

EXT: Input signal of external trigger (CH4) input terminal (36) is used as trigger signal.

EXT ÷ 5 : Input signal of external trigger (CH4) input terminal (36) is attenuated to 1/5 and used as trigger signal.

SOURCE ..... (48)

Selects between continuous delay and triggered delay; selects the trigger signal source for the B trigger circuit.

START AFTER DELAY:
Selects the continuous delay mode independent of the B trigger signal.

The B sweep starts immediately after the period determened by DELAY TIME switch (39) and DELAY TIME MULTI switch (47) has elapsed.

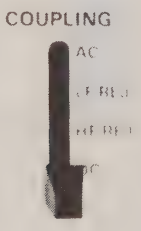
If this switch is set in any other position, the B sweep operates in the triggered delay mode, and it starts when the sweep delay time has elapsed after the B trigger signal has been applied.

INT: Internal trigger signal selected by INT TRIG switch (19) is used as trigger signal.

EXT: Input signal of external trigger (CH5) input terminal (46) is used as trigger signal.

EXT ÷ 5: Input signal of external trigger (CH5) input terminal (46) is attenuated to 1/5 and used as trigger signal.

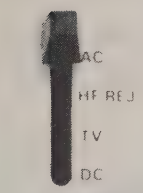
COUPLING ..... (34) (49) Select coupling modes between trigger signal sources and trigger circuits;



AC: AC coupling

LF REJ: AC coupling, with components lower than 50 Hz rejected.

HF REJ: AC coupling, with components higher than 50 Hz rejected.



COUPLING

DC: DC coupling

TV: The sweep circuit is connected to the TV sync separator circuit and the sweeps are triggered with TV V or TV H signal at a rate selected by the A TIME/DIV switch (39)

TV V: 0.5 sec/DIV - 0.1 msec/DIV
TV H: 50 µsec/DIV - 20 nsec/DIV.

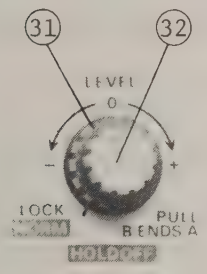
SLOPE ..... (33) (50) Selects the triggering slope.

"+": Triggering occurs when the trigger signal crosses the trigger level in positive-going direction.

"-": Triggering occurs when the trigger signal crosses the trigger level in negative-going direction.

HOLDOFF ..... (31)
LEVEL ..... (32)

These double-knob controls are for holdoff time adjustment and trigger level adjustment. The pulled out position of the LEVEL knob is for the B END'S A mode.



The HOLDOFF time control is used when the signal waveform is complex and stable triggering cannot be attained with LEVEL knob (32) alone.

The LEVEL knob is for displaying a synchronized stationary waveform and setting a start point for the waveform.

As this knob is turned in "→+" direction, the trigger level moves upward on the displayed waveform; as the knob is turned "-←", the level moves downward.

When set in the LOCK position, the trigger level is automatically maintained at an optimal value irrespective of the signal amplitude and for most signals requires no manual adjustment of the trigger level. When the signal level is at the trigger level, the TRIG'D LED (37) turns on.

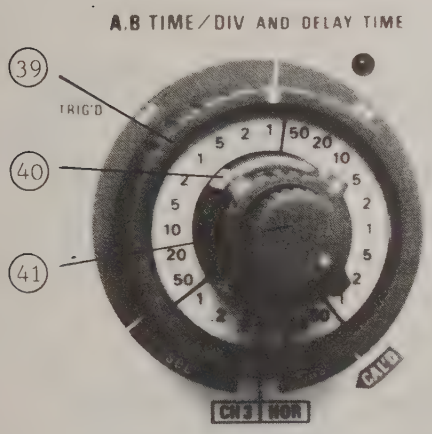
When in the B END'S A mode, the A sweep ends at the same time the B sweep ends. With this function, degradation of brightness can be minimized when in the delayed sweep mode with large magnification of waveform in the horizontal direction.

LEVEL..... (51)
TRACE SEP ..... (52)

These double-knob controls are for level adjustment and trace separation adjustment. The functions of the LEVEL knob (51) are the same as those of the LEVEL knob (32). The function of the TRACE SEP knob is to control the vertical distance between A sweep and B sweep when in the ALT sweep mode.

o Time Base

A, B TIME/DIV ..... (39)
AND DELAY TIME (40)



The large knob (39) is for A TIME/DIV and DELAY TIME, and the medium knob (40) is for B TIME/DIV.

The A TIME/DIV knob sets the A sweep rate; the DELAY TIME knob sets the delayed sweep rate.

The B TIME/DIV switch sets the delayed sweep (B sweep) time.

When the TIME/DIV switch is set in the CH3|HOR position, the oscilloscope operates as a multichannel X-Y scope with CH3 channel as the X axis and other channels as the Y axis. (For details, see page 49.)

A VARIABLE ..... (41)
PULL ×10 MAG

For continuously variable adjustment of A sweep rate and for ×10 MAG function.

The value indicated by A TIME/DIV switch can be reduced by a factor of 2.5 or more. When set in the CAL'D position, the sweep speed is calibrated to the value indicated by the A TIME/DIV switch. When not in the CAL'D position, the UNCAL lamp (38) turns on.

When the knob is pulled out, the A or B sweep is expanded by 10 times.

POSITION ..... (44)
FINE ..... (45)

For horizontal positioning of spot or trace. The larger knob is for coase adjustment and the smaller for fine adjustment.

DELAY TIME ..... (47)
MULTI

Multi-turn potentiometer for continuously variable adjustment of the delay time indicated by the A sweep knob (39) in order to select the section to be expanded of the A sweep.

SWEEP MODE ..... (30)

Selects the desired sweep mode.

AUTO: When no triggering signal is applied or when triggering signal frequency is less than 50 Hz, sweep runs in the free mode.

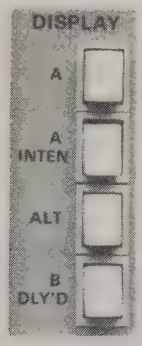
NORM: When no triggering signal is applied; sweep is in a ready state and the trace is blanked out. Used primarily for observation of signals of 50 Hz or lower.

SINGLE: Used for single sweep (PUSH TO RESET) operation (one-shot sweep operation) in conjunction with the reset switch.

When the three buttons are in the pushed out state, the circuit is in the single sweep mode. The circuit is reset as

this button is pressed. When the circuit is reset, the READY lamp (42) turns on. The lamp goes off when the single sweep operation is over.

DISPLAY ..... (29) Selects A and B sweep mode as follows:



A: Main sweep (A sweep) mode for general waveform observation.

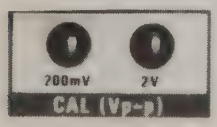
A INTEN: This sweep mode is used when selecting the section of the A sweep to be magnified for delayed sweep. The B sweep section (delayed sweep) is displayed with high brightness.

ALT: A INTEN sweep and B sweep (delayed sweep) are displayed alternately. (The A, B TRACE SEPARATION control (52) adjusts the distance between these traces.)

B: Displays the delayed sweep (B sweep) alone.

o Others

CAL (Vp-p) ..... (43) These terminals deliver the calibration voltage of approximately 1 kHz, positive square wave.



200 mV: Delivers 200 mVp-p signal. Output resistance approximately 200 Ω.

2 V: Delivers 2 Vp-p signal. Output resistance is approximately 2 kΩ.

..... (53) Ground terminal of oscilloscope mainframe.

4.2 Explanation of Rear Panel (See Figure 4-2.)

o Z Axis

A AXIS INPUT ..... (54) Input terminals for external intensity modulation signal.

o Output Terminals

CH1 SIGNAL OUTPUT ... (55) Delivers the CH1 signal with a voltage of approximately 10 mV per 1 DIV on screen (when terminated with 50 ohms). May be used for frequency counting, etc.

A GATE OUTPUT ..... (56) Delivers the A sweep gate signal. Output resistance is approximately 50 Ω.

A SWEEP OUTPUT ..... (57) Delivers the A sweep waveform signal. Output resistance is approximately 10 kΩ.

o Vertical Axes

CH4 POSITION ..... (59) Vertical positioning of the spot or trace of CH4 (A TRIG VIEW).

CH5 POSITION ..... (60) Vertical positioning of the spot or trace of CH5 (B TRIG VIEW).

o AC Power Input Circuit

AC power input connector ..... (61)
Input connector of the AC power of the instrument. Connect the AC power cord (supplied) to this connector.

FUSE ..... (62) Fuse in the primary circuit of the power transformer. Fuse rating is as shown in Table (63)

AC voltage selecting connector ..... (64)
For selecting the AC voltage of the instrument.

AC voltage selector plug ..... (65)
For selecting the AC voltage of the instrument by aligning its arrowhead mark in the corresponding position as shown in Table (63)

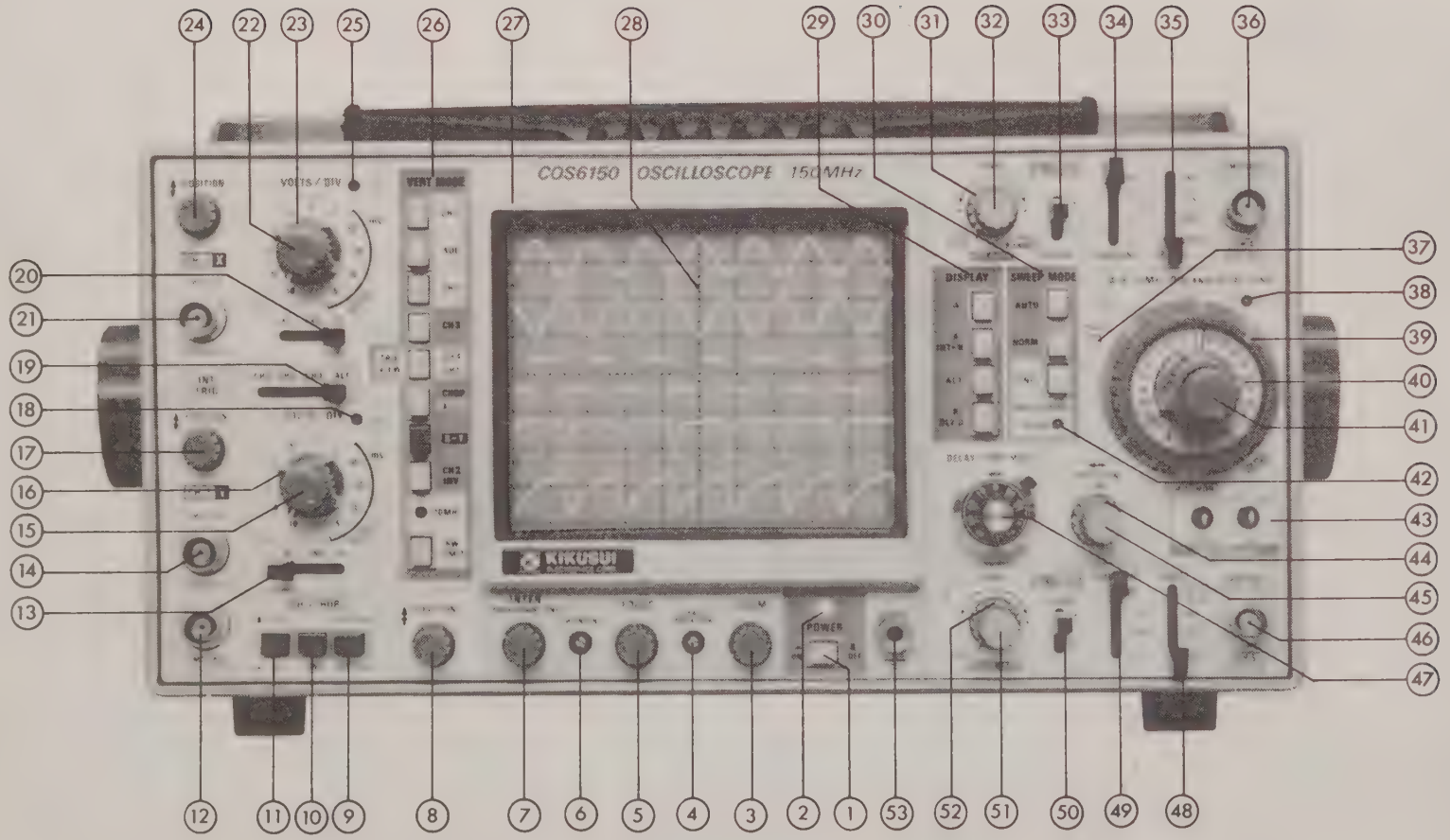

COS6150 OSCILLOSCOPE 150MHz
VOLTS / DIV
VERT MODE
DISPLAY
SWEEP MODE
AUTO
NORM
KIKUSUI
POWER
1
2
3
4
5
6
7
8
9
10
11
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Figure 4-1

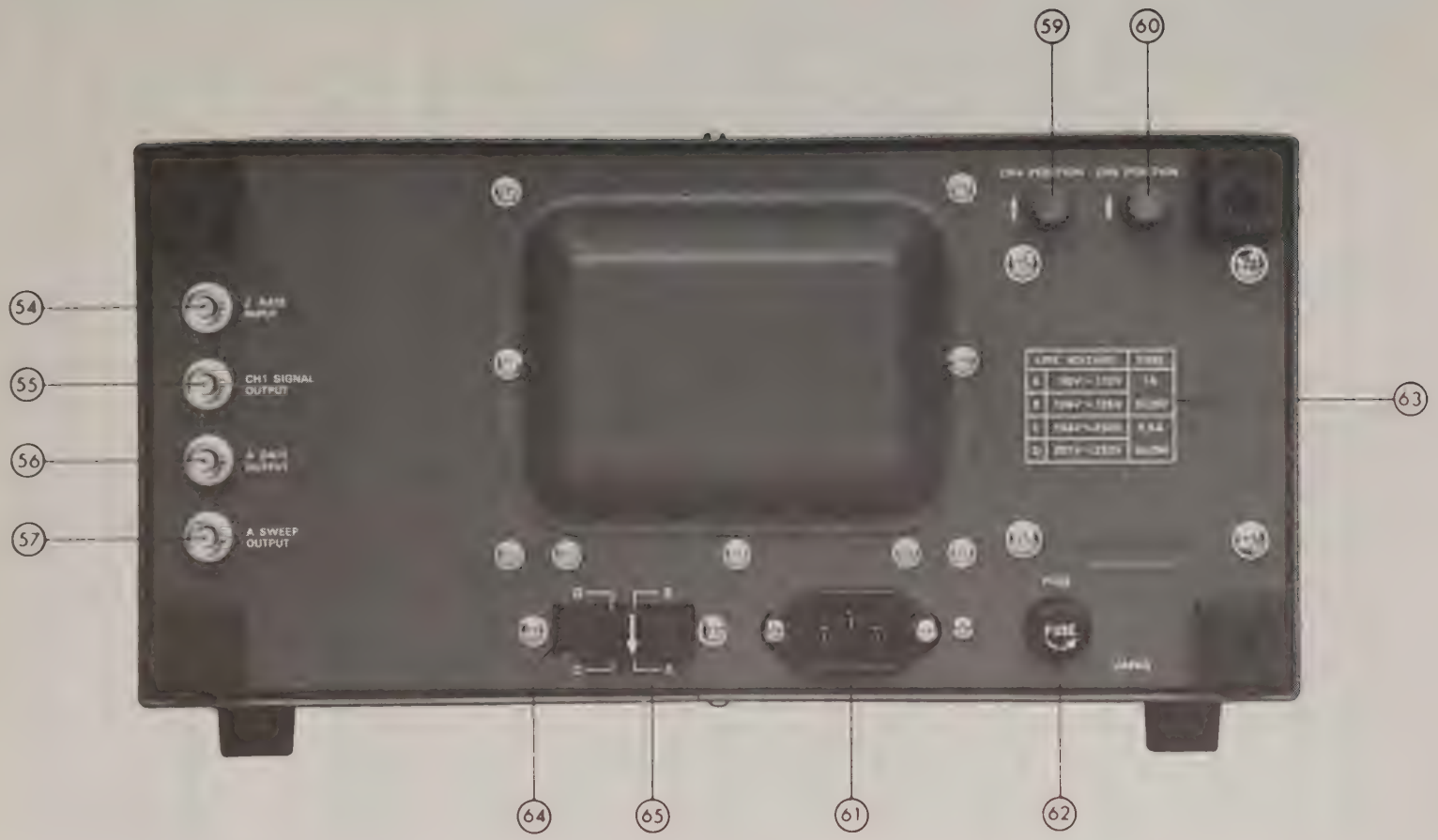


Figure 4-2

4.3 Basic Operation

Before connecting the power cord to an AC line outlet, check that the AC line voltage selector plug on the rear panel of the instrument is correctly set for the AC line voltage. After ensuring the voltage setting, set the switches and controls of the instrument as shown in the following table.

Item	No.	Setting
POWER	①	⊓ OFF position
INTEN	⑦	Clockwise (3-o'clock position)
FOCUS	⑤	Mid-position
ILLUM	③	Counterclockwise position
VERT MODE	㉖	All buttons in ⊓ state
↕ POSITION	⑧ ⑰ ㉔ ㊾ ㊿	Mid-position Mid-position (on rear panel)
VOLTS/DIV	⑯ ㉓	50 mV
VARIABLE (×5 MAG)	⑮ ㉒	CAL'D (clockwise position) Depressed state
AC-GND-DC	⑬ ⑳	GND
AC/DC /GND	⑪ ⑩	⊓ AC ⎍
0.1V/0.5V	⑨	⊓ 0.1V
INT TRIG	⑲	ALT
SOURCE	㉟ ㊽	INT START AFTER DELAY
COUPLING	㉞ ㊾	AC
SLOPE	㉝ ㊿	+
LEVEL	㉜ ㊶	LOCK (counterclockwise)

Item	No.	Setting
HOLDOFF	(31)	NORM (counterclockwise)
↕ TRACE SEP	(52)	Mid-position
SWEEP MODE	(30)	AUTO
DISPLAY	(29)	A
A, B TIME/DIV	(39) (40)	0.5 msec
VARIABLE ×10 MAG	(41)	CAL'D (clockwise position) Depressed state
↔ POSITION	(44)	Mid-position
(FINE)	(45)	Mid-position

After setting the switches and controls as above, connect the power cord to the AC line outlet and, then, proceed as follows:

1) Turn-ON the POWER switch and make sure that the power pilot LED above is turned on. In about 20 seconds, a trace will appear on the CRT screen. If no trace appears in about 60 seconds,verify the switch and control settings as shown in the above table.

2) Adjust the trace to an appropriate brightness and sharpest image with the INTEN control and FOCUS control.

3) Align the trace with the horizontal center line of graticule by adjusting the CH1 POSITION control and TRACE ROTATION control (screwdriver adjust).

4) Connect the probe (in the 10:1 division ratio, supplied) to the CH1 INPUT terminal, and apply the 200 mVp-p CALIBRATOR signal to the probe tip.

5) Set the AC-GND-DC switch in the AC state. A waveform as shown in Figure 4-3 will be displayed on the CRT screen.

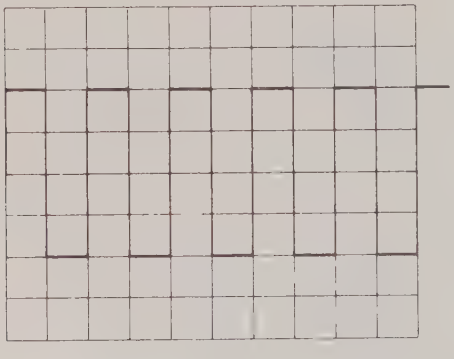


Figure 4-3

6) Adjust the FOCUS control so that the trace image becomes sharpest. No re-adjustment will be necessary as the linear focus circuit will automatically maintain the image in this best focussed state.

7) For signal observation, set the VOLTS/DIV switch and TIME/DIV switch in appropriate positions so that the signal waveform is displayed with an appropriate amplitude and an appropriate number of peaks.

8) Adjust the ↕ POSITION and ↔ POSITION controls in appropriate positions so that the displayed waveform is aligned with the graticule and the voltage (Vp-p) and period (T) can be read conveniently.

The above is the basic operating procedure of the oscilloscope. Further operation methods are explained in the subsequent paragraphs.

4.4 Vertical Mode Switches

The vertical mode switches of the oscilloscope are comprised of five types of mode selector switches as shown in the following:

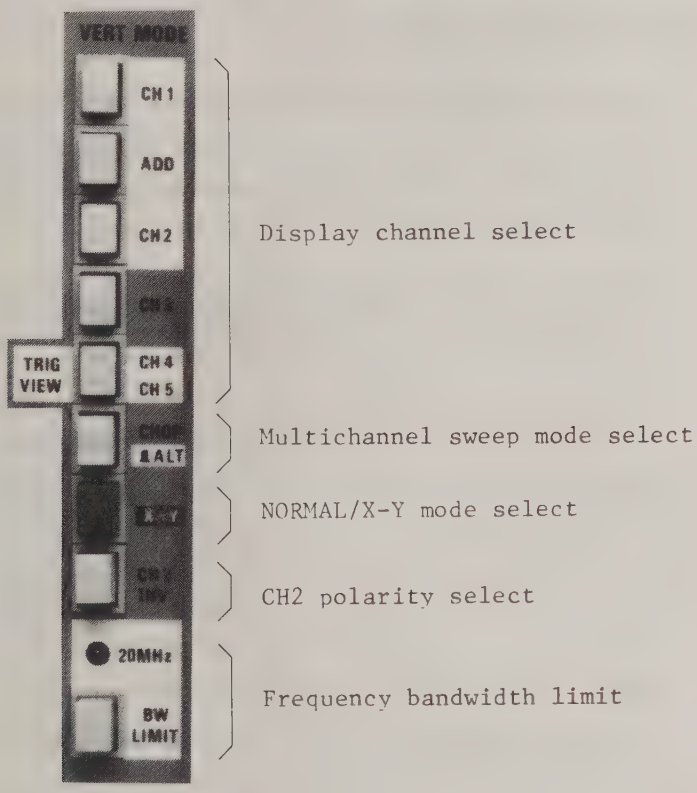


Figure 4-4

These mode switches can be set in any combination.

(1) Single-channel operation

For the signal-channel operation, depress one of the display channel buttons (⊓) and leave the remaining display channel buttons extended (Д). If none of the display channel buttons are depressed (Д), CH1 signal is displayed.

Note: Either CH1, ADD (CH1 + CH2), CH2, CH3, or TRIG VIEW (CH4) can be viewed independently of each other. TRIG VIEW (CH5) may not be viewed independently of CH4.

(2) Multichannel operation

For multichannel operation, depress only the required display channel buttons and leave all other vertical mode buttons extended. Set the CHOP/ALT button in the CHOP or ALT mode as required.

When in the CHOP mode, the channel signals are chopped in sequence at a rate of about 1 μsec (1 MHz). Multichannel traces are simultaneously displayed in a time-slicing method. When signal frequencies are high, the waveforms may be displayed with dotted lines. In such cases the ALT mode should be used.

When in the ALT mode, one channel is displayed for an entire sweep, then the next channel is displayed for an entire sweep. This mode is used primarily for display of high frequency signals at fast sweep speeds. At very low sweep speeds, signals are displayed alternately. In such cases the CHOP mode should be used.

Note: The multichannel operation can be done with any combinations of CH1, ADD (CH1 + CH2), CH2, CH3, and TRIG VIEW (CH4 and CH5). The last item means that the CH5 channel can be displayed only when the CH4 (TRIG VIEW) display is selected. The CH5 channel is displayed when the SOURCE switch (48) is set in the INT, EXT, or EXT (÷5) position.

(3) X-Y operation

Simply by depressing the [X-Y] button, the oscilloscope operates as an X-Y scope. This button has the highest priority over all other vertical mode selector buttons. The X-Y operation is with CH1 as X axis and CH2 as Y axis. The bandwidth of the X axis is DC to 5 MHz (-3 dB) and the CH1 POSITION control (24) is used as the X axis (↔) POSITION control. Other electrical performances remain the same as when the circuit is used as the CH1 vertical channel. The Y axis operates with the same electrical performances as when the circuit is used as the CH2 vertical channel, and its operation method remains the same.

When the calibration voltage signal is applied to the input terminals of both X and Y axis with the probes (in the 10:1 division ratio, supplied) and the corresponding VOLTS/DIV switches are properly adjusted, a Lissajous figure as shown in Figure 4-5 will be displayed.

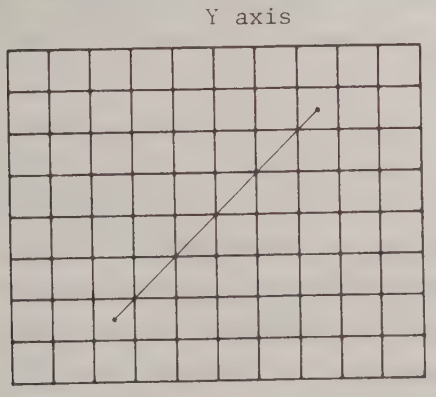


Figure 4-5

Note: When high frequency signals are displayed in the X-Y operation, pay attention to the frequency bandwidths of and phase difference between X and Y axes.

(4) ADD operation

An algebraic sum of the CH1 and CH2 signals can be displayed on the screen by depressing the ADD switch. The displayed signal is the difference between CH1 and CH2 signals if the CH2 POLARITY switch is set in the INV (⊓) state.

For accurate addition or subtraction, it is a prerequisite that the sensitivities of the two channels are adjusted accurately to the same value. Vertical positioning can be done with the ↕ POSITION knob of either channel. In view of the linearities of the vertical amplifiers, it is most advantageous to set them in their mid-positions.

(5) BW LIMIT mode

When the BW LIMIT button is depressed (⊓), a bandpass filter of approximately 20 MHz is inserted in the vertical amplifier. When in this mode of operation, higher frequency components and noise components are eliminated from the displayed signal. Another advantage of this mode is that the internal noise components are eliminated and consequently a clear waveform is displayed. This mode is suitable for use at lower frequencies.

4.5 CH3 HOR Operation

When the A TIME/DIV switch is set in the CH3 HOR position, the oscilloscope operates as a multichannel X-Y scope with the channels (except CH3) selected by the vertical mode switches as the Y axis and CH3 as the X axis. The bandwidth of the X axis becomes DC - 5 MHz (-3 dB). The vertical (↕) POSITION knob (8) can be used as the horizontal (↔) POSITION knob. Other electrical performances are the same as CH3. Regarding the Y axis, the channels selected by the vertical mode switches are displayed in the CHOP mode, with the electrical performances and the operation method remaining the same.

4.6 Triggering

Proper triggering is essential for efficient operation of an oscilloscope. The user of the oscilloscope must make himself thoroughly familiar with the triggering functions and procedures.

(1) Functions of INT TRIG (internal trigger) switch:

The signals applied to the input terminals of CH1, CH2 and CH3 are picked off from respective preamplifiers in order to be used as internal trigger signals. The INT TRIG switch selects these signals. The selected signals are sent to the A trigger circuit or the B trigger circuit through the SOURCE switch. The relationships of these circuits are shown in the block diagram of Figure 4-6.

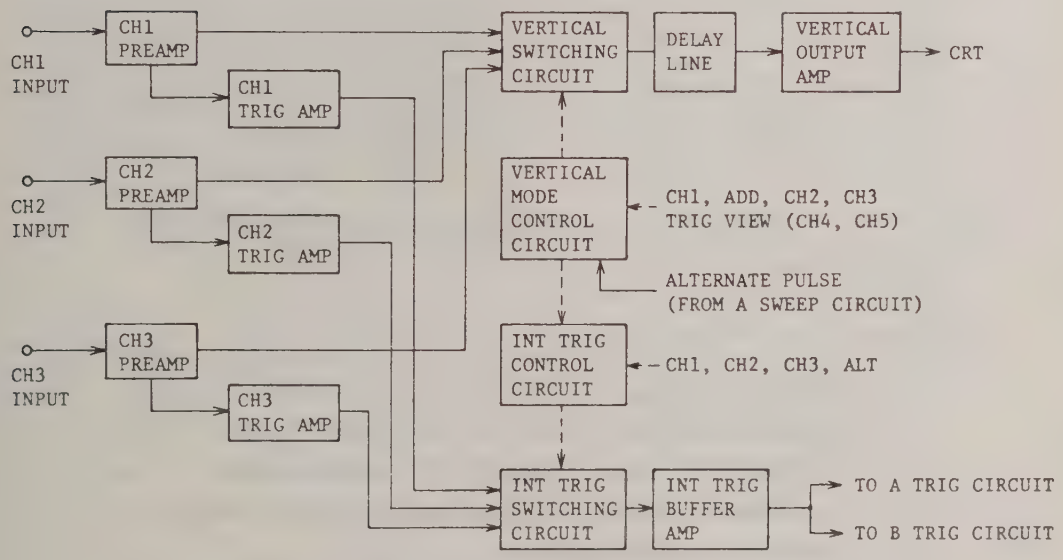


Figure 4-6

With the INT TRIG switch the internal trigger signal can be selected as follows.

CH1: Input signal of CH1
CH2: Input signal of CH2
CH3: Input signal of CH3
ALT: All signals being displayed on screen

As can be seen in the block diagram, the triggering circuits are designed with certain relationships to the vertical mode selector switches. These relationships are shown in the following table.

INT TRIG \ MODE	CH1	ADD	CH2	CH3	TRIG VIEW	
					CH4	CH5
CH1	Trig by CH1					
CH2	Trig by CH2					
CH3	Trig by CH3					
ALT	Trig by CH1	Trig by CH1	Trig by CH2	Trig by CH3	(Trig by CH1)	(Trig by CH1)

The items enclosed in the parentheses are for the TRIG VIEW (INT TRIG) mode.

Notes: 1. When in the ALT mode, two or more signals of CH1, CH2 and CH3 use the same trigger circuit alternately. Therefore, These signals must cross the same trigger level. Pay attention to the DC components of these signals. It is necessary to use TRIG LEVEL knob (21) and DC coupling mode for best triggering.

2. Note that jitter may be produced when the sweep speed is slow if the SOURCE switch is set for AC coupling.
3. The ALT trigger function for vertical modes is effective only when in the single-channel operation and when in the ALT-mode multichannel operation. It is not effective when in the CHOP mode.
4. 3 cycles or more on the C.R.T must be displayed to obtain observation of complete triggering signal.

(2) Function of SOURCE Switch:

To display a stationary pattern on the CRT screen, the displayed signal itself or a trigger signal which has a time relationship with the displayed signal is required to be applied to the trigger circuit. The SOURCE switch selects such a trigger source.

INT: This internal trigger method is used most commonly. The signal applied to the vertical input terminal (the measured signal) is branched off from a point in the amplifier circuit and is fed to the trigger circuit through the INT TRIG switch. Since the trigger signal is the measured signal itself, a very stable waveform can be readily displayed on the CRT screen.

LINE: The AC power line frequency signal is used as the trigger signal. This method is effective when the measured signal has a relationship with the AC line frequency, especially for measurements of low level AC noise of audio circuits, thyristor circuits, etc.

EXT: The sweep is triggered with an external signal applied to the external trigger input terminal (CH4 or CH5). An external signal which has a periodic relationship with respect to the measured signal is used. Since the measured signal (vertical input signal) is not used as the trigger signal, the waveform display can be done independent of the measured signal. (Select CH4 or CH5 input signal.)

EXT ÷ 5: The external trigger signal applied to the external trigger input terminal is attenuated into 1/5 before being applied to the trigger circuit. Operation is the same with those of the EXT trigger mode. This mode is used when the external trigger signal level is too high.

START AFTER DELAY: This position is for continuous sweep delay (B sweep) mode. When in other position (INT or EXT (÷ 5)), the sweep runs in the triggered delay mode. (When in the START AFTER DELAY position, the CH5 signal is not displayed if the vertical mode selector switch is set in the TRIG VIEW position.)

(3) Functions of COUPLING switch:

This switch is used to select the coupling of the trigger signal to the trigger circuit in accordance with the characteristics of the measured signal.

AC: This coupling is for AC triggering which is used most commonly. As the trigger signal is applied to the trigger circuit through an AC coupling circuit, stable triggering can be attained without being affected by the DC component of the input signal. The low-range cut off frequency is 3 Hz (-3 dB).

When the ALT trigger mode is used and the sweep speed is slow, jitter may be produced. In such a case, use the DC mode.

LF REJ: The trigger signal is fed to the trigger circuit through an AC coupling circuit and a high pass filter (approximately 50 kHz, -3 dB). The DC component, AC noise and other low frequency components are rejected. Only the higher frequency components of the trigger signal are applied to the trigger circuit.

HF REJ: The trigger signal is fed to the trigger circuit through an AC coupling circuit and a low pass filter (approximately 50 kHz, -3 dB). The higher frequency components of the trigger signal are rejected. Only the lower frequency components of the trigger signal are applied to the trigger circuit.

This feature is used for more stable triggering when the triggering signal has large noise or when the oscilloscope is set at a high sensitivity thereby making triggering unstable.

TV: This coupling is triggering of TV video signals. The trigger signal is AC-coupled and fed via the trigger circuit (level circuit) to the TV sync separator circuit. The separator circuit picks off the sync signal, which is used to trigger the sweep. Thus, the video signal can be displayed very stably.

Being linked to the TIME/DIV switch, the sweep speed is switched for TV.V and TV.H as follows:

TV.V: 0.5 sec - 0.1 msec
TV.H: 50 µsec - 20 nsec

The SLOPE switch should be set in conformity with the video signal as shown in Figure 4-7.

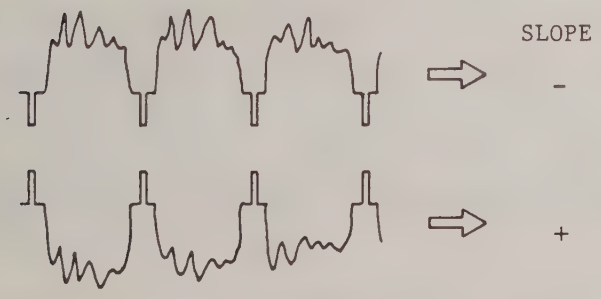


Figure 4-7

DC: The trigger signal is DC-coupled to the trigger circuit. This mode is used when triggering on a DC component of a signal or when triggering on very low frequency signals.

(4) Functions of SLOPE switch:

This switch selects the slope (polarity) of the trigger signal.

"+": When set in the "+" state, triggering occurs as the trigger signal crosses the trigger level in the positive-going direction.

"-": When set in the "-" state, triggering occurs as the trigger signal crosses the trigger level in the negative-going direction.

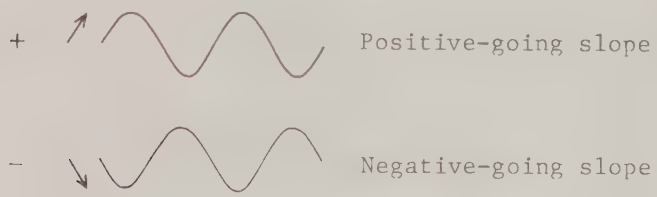


Figure 4-8

(5) Functions of LEVEL (LOCK) control:

The function of this control is to adjust the trigger level and display a stationary image. At the instant the trigger signal has crossed the trigger level set by this control, the sweep is triggered and a waveform is displayed on the screen.

The trigger level changes in the positive direction (upward) as this control knob is turned clockwise and it changes in the negative direction (downward) as the knob is turned counterclockwise. The rate of change is set as shown in Figure 4-9.

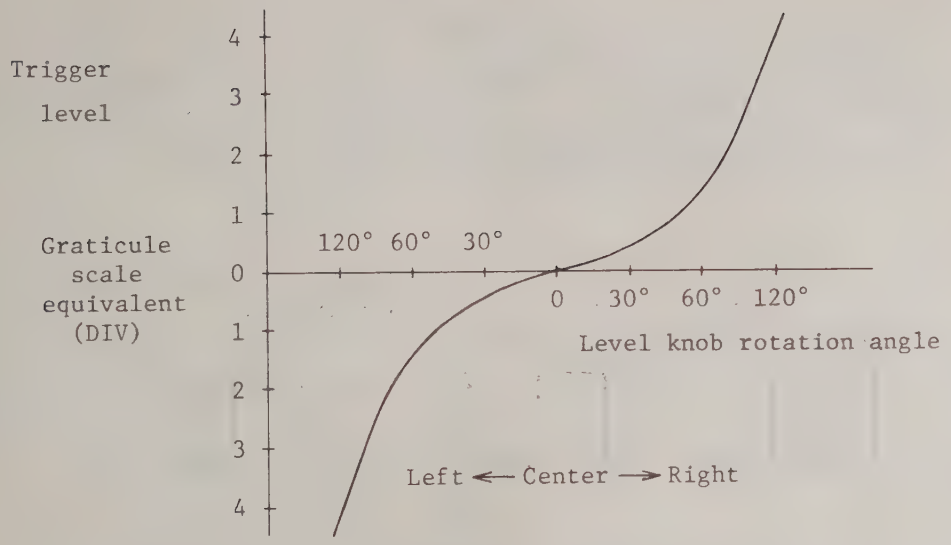


Figure 4-9

o LEVEL LOCK

When the LEVEL knob is set in the LEVEL LOCK position, the trigger level is automatically maintained within the amplitude of the trigger signal and stable triggering can be done without requiring level adjustment (although jitter may not be suppressed when in the ALT mode). This automatic level lock function is effective when the signal amplitude on the screen or the external trigger input voltage is within the following range:

50 Hz - 20 MHz: 0.9 DIV (0.09 V) or less
50 Hz - 100 MHz: 2.0 DIV (0.2 V) or less
Note ( ): External trigger signal

(6) Functions of A HOLDOFF control:

When the measured signal is a complex waveform with two or more repetition frequencies (periods), triggering with the above-mentioned LEVEL control alone may not be sufficient

for attaining a stable waveform display. In such a case, the sweep can be stably synchronized to the measured signal waveform by adjusting the HOLDOFF time (sweep pause time) of the sweep waveform. The control covers at least the time of one full sweep, for sweeps faster than 0.2 sec/DIV.

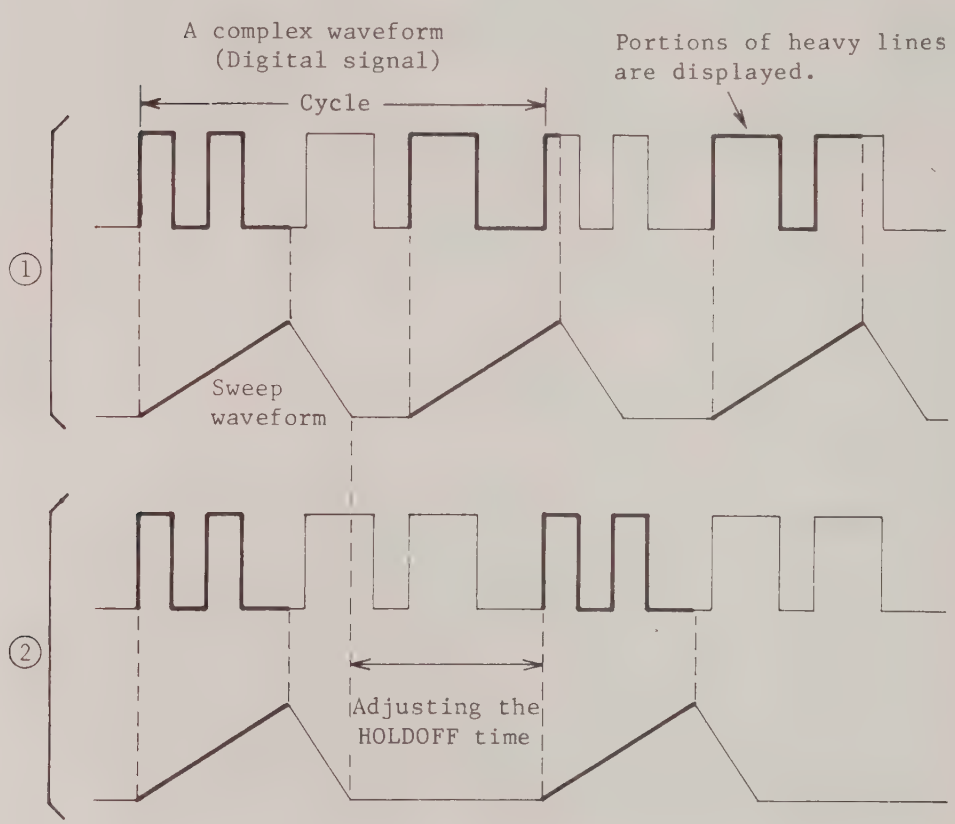


Figure 4-10

Figure 4-10 ① shows a case where the HOLDOFF knob is in the NORM state and various different waveforms are overlapped on the screen, making the signal observation unsuccessful.

Figure 4-10 ② shows a case where the undesirable portion of the signal is with held and the same waveforms are displayed on the screen.

4.7 Single-sweep Operation

Non-repetitive signals and one-shot transiential signals can hardly be observed on the screen. Such signals can be measured by displaying them in the single-sweep mode on the screen and photographing them.

o Measurement of non-repetitive signal:

(1) Set the DISPLAY in the "A" state and the SWEEP MODE in the NORM state.

(2) Apply the measured signal to the vertical input terminal and adjust the trigger level.

(3) Set the SWEEP MODE in the SINGLE state (the three push-button switches are up).

(4) Press the RESET button. The sweep will run only for one cycle and the measured signal will be displayed only once on the screen.

o Measurement of one-shot signal:

(1) Set the DISPLAY in the "A" state and the SWEEP MODE in the NORM state.

(2) Apply the calibration output signal to the vertical input terminal, and adjust the trigger level to a value corresponding to the predicted amplitude of the measured signal.

(3) Set the SWEEP MODE in the SINGLE state. Apply the measured signal instead of the calibration signal to the vertical input terminal.

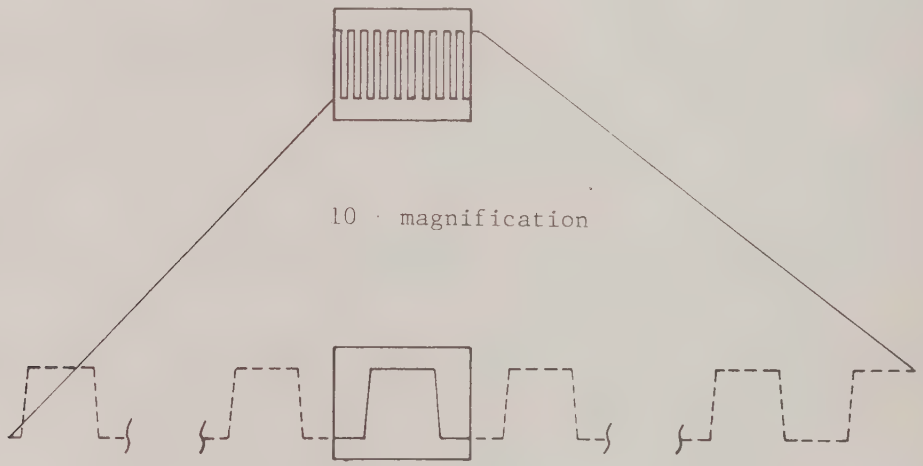
(4) Depress the RESET button. The sweep circuit will become the ready state and the READY lamp will turn on.

(5) As the one-shot signal occurs in the input circuit, the sweep runs only for one cycle and the one-shot signal is displayed on the CRT screen.

The single-sweep operation can be done also with A INTEN B sweep. However, it cannot be done in the multichannel ALT mode operation. For multichannel one-sweep operation, use the CHOP mode.

4.8 Sweep Magnification

When a certain part of the displayed waveform needs to be magnified, a faster sweep speed (MAG) may be used. In such a case, pull out the sweep VARIABLE knob (41) (set in the ×10 MAG state). When this is done, the displayed waveform is expanded by 10 times. The center of the waveform will be displayed. Any part can be covered by means of POSITION control.



Any part can be covered by means of POSITION control.

Figure 4-11

When the sweep is magnified and the sweep speed has become faster than 20 nsec/DIV, the trace intensity may be reduced. In such a case, the displayed waveform should be expanded in the B sweep mode explained in the subsequent paragraphs.

4.9 Waveform Magnification with Delayed Sweep

With sweep magnification (described above), the magnification ratio is limited to 10×. With the delayed sweep method, the sweep can be expanded for a wide range of from several times to several thousand times depending on ratio between A sweep time and B sweep time.

As the measured signal frequency becomes high and the A sweep range for the non-expanded signal becomes higher, the available expansion ratio becomes smaller. Furthermore, as the magnification ratio becomes larger, the trace intensity becomes lower and the delay jitter increases. To cope with this situation, a triggered delay circuit and a B ENDS A circuit are provided.

(1) Continuous delay:

Set the DISPLAY switch to A and display the signal waveform with the A sweep in the regular operation method.

Next, set the B TIME/DIV switch to a position faster than that of the A TIME/DIV switch.

After ensuring that the SOURCE switch (48) is set in the START AFTER DELAY state, turn the DISPLAY switch to the A INTEN position. A part of the displayed waveform will be accentuated as shown in Figure 4-12, indicating the state ready for delayed sweep. The intensified portion denotes the section corresponding to the B sweep time (DELAYED SWEEP).

The period from the start of the A sweep to the beginning of B sweep (the accentuated portion of the trace) is called "SWEEP DELAY TIME". This period is continuously variable by means of the DELAY TIME MULTI dial.

Next, change the DISPLAY switch to the B position. The B sweep time will be expanded to a full sweep (10 cm) as shown in Figure 4-13.

The B sweep time is set by the B TIME/DIV switch and the magnification ratio becomes as follows:

$$\text{Magnification ratio} = \frac{\text{A TIME/DIV indication}}{\text{B TIME/DIV indication}}$$

The sweep delay time can be read on the CRT screen. For more accurate determination, the DELAY TIME MULTI dial should be used.

$$\text{Sweep delay time} = \text{A TIME/DIV indication} \times \text{DELAY TIME MULTI dial setting}$$

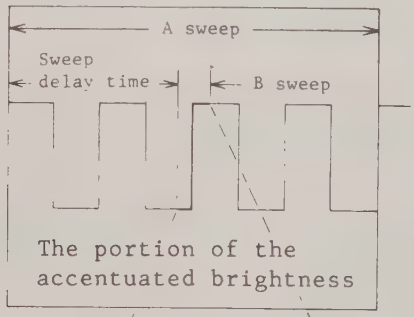


Figure 4-12

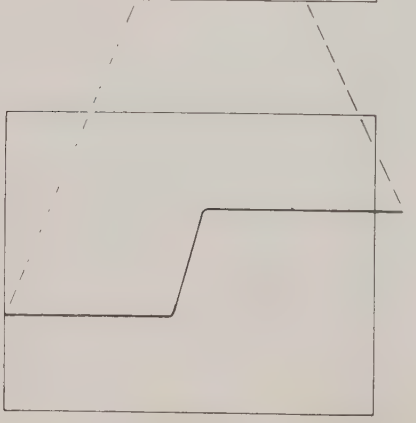


Figure 4-13

(2) Triggered delay:

When the displayed waveform is magnified by 100 times or more by the continuous delay method, delay jitter is produced. To suppress the jitter, a triggered delay method may be used.

For this operation, the B trigger circuit operates when the SOURCE switch (48) is set in the INT state and the B sweep is triggered by the B trigger pulse. Therefore, even when the delay time is continuously varied by rotating the DELAY TIME MULTI dial, the starting point does not vary continuously but varies intermittently. This operation when in the A INTEN mode can be observed as the intensified section jumps from trigger point to trigger point on the A sweep waveform.

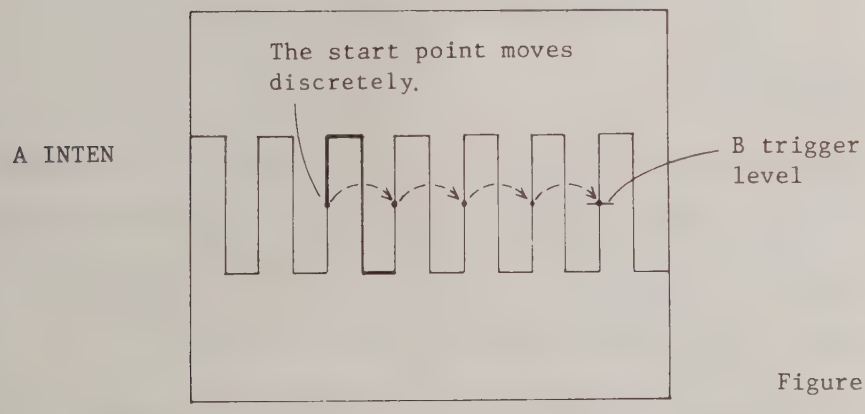


Figure 4-14

4.10 Delayed ALT Sweep

When in the Delayed ALT sweep mode, the A sweep and B sweep (delayed sweep) are displayed alternately on the screen, enabling you to observe at the same time the unmagnified waveform and magnified section.

To prevent the two waveforms from overlapping and to display them separately, adjusted the TRACE SEP control (52).

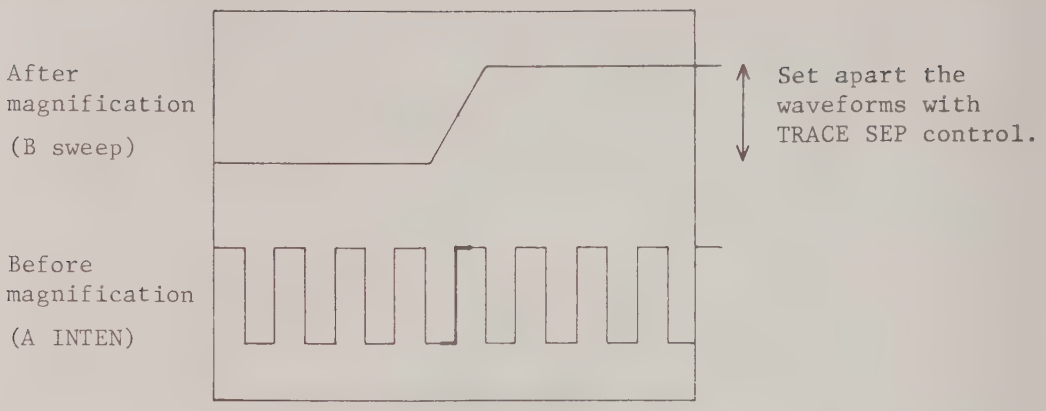


Figure 4-15

Note: The delayed ALT sweep mode can be used in combination with the multichannel mode (CHOP or ALT) of the vertical axes.

4.11 B ENDS A Mode

When the trace is magnified by a large ratio with the delayed sweep, the magnified trace may become dim and hardly discernible. By ending the A sweep at the minimum required point, the display time for the B sweep is increased so that the trace does not become dim. The B ENDS A mode should be used.

The operating method is the same as that of Subsections 4.9 and 4.10. Pull out the LEVEL knob (32) to set it in the B END A state, and a bright magnified trace shown in Figure 4-16 will be displayed.

Turn the A HOLD OFF knob (31) to the extreme clockwise position (B ENDS A position). A bright magnified trace as shown in Figure 4-16 will be displayed.

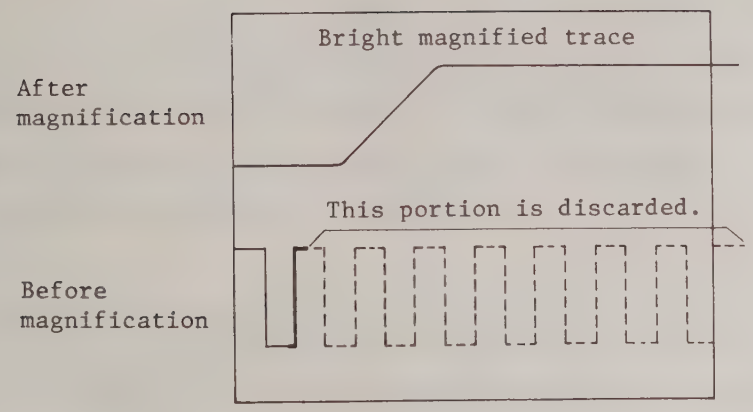

Bright magnified trace
After magnification
This portion is discarded.
Before magnification

Figure 4-16

5. MEASURING METHODS

5.1 Connection Method of Input Signal

The input impedance of the oscilloscope as viewed from the vertical input terminal is 1 MΩ with capacitance approximately 20 pF in parallel. When the probe 10:1 is used, the impedance increases to resistance 10 MΩ with capacitance approximately 13 pF in parallel.

There are various methods of connecting the signal sources to the oscilloscope. The most popular methods are with regular covered wires, with shielded wires, with a probe, or with a coaxial cable. The following factors should be considered.

Output impedance of input signal source
Level and frequency of input signal
External induction
Distance between the input signal source and the oscilloscope

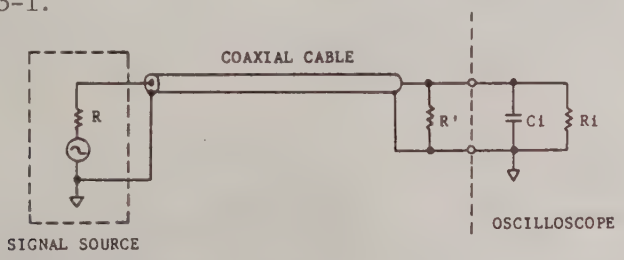
Types of input signals and connection methods are tabulated in the following:

Type of input signal \ Connection method			Probe	Coaxial cable
Low frequency	Low impedance	Near	○	○
		Far		○
	High impedance	Near	○	◍
		Far		◍
High frequency	Low impedance	Near	○	○
		Far		○
	High impedance	Near	○	◍
		Far		

(○: Good, ◍: Fair)

o Connection with coaxial cable:

When the output impedance of the signal source is 50Ω or 75Ω, the input signal can be fed without attenuation by using a coaxial cable which enables impedance matching.
For impedance matching, terminate the coaxial cable with a 50Ω or 75Ω pure-resistive resistor corresponding to the characteristic impedance of coaxial cable, as shown in Figure 5-1.

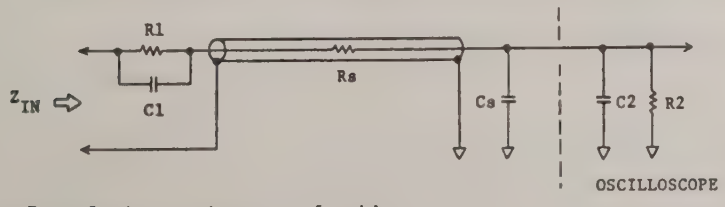


R = R'
When R = 50 Ω, use a 50 Ω coaxial cable.
When R = 75 Ω, use a 75 Ω coaxial cable.

Figure 5-1

o Connection with probe:

Two probes with an attenuation ratio of 10:1 are supplied. The probe circuit and probe cable are shielded to prevent induction noise. The probe circuit makes up a wide-range attenuator in conjunction with the input circuit of the oscilloscope, thereby enabling a distortionless connection from DC to high frequencies. When the probe is used, although the signal level is attenuated to 1/10, the input impedance becomes very high (resistance 10 MΩ, capacitance approx. 13 pF) and the loading effect on the measured signal source is greatly reduced as explained in the following.



Rs = Series resistance of cable
Cs = Stray capacitance plus cable capacitance

Figure 5-2

The probe makes up an attenuator with resistor R1, in the probe, and the input resistor R2, in the oscilloscope. Capacitor C1 compensates for input capacitor C2 in the oscilloscope and stray capacitance (Cs) in the cable. The input impedance Z_{IN} is expressed as follows:

$$Z_{IN} = \frac{R1 + R2}{\omega C (R1 + R2) + 1}$$

$$C = \frac{C1 \times (C2 + Cs)}{C1 + C2 + Cs}$$

Attenuation ratio A is expressed as follows:

$$A = \frac{R2}{R1 + R2} \quad \left(= \frac{1\ M\Omega}{9\ M\Omega + 1\ M\Omega} = \frac{1}{10} \right)$$

The terms enclosed in the parentheses are for the factor when the probe is used:

Precautions:

- o Observe the maximum allowable input voltages mentioned in Section 3.5.
- o Do not fail to use the ground lead supplied.
- o Before taking measurement, accurately adjust the frequency compensation of the probe without fail.
- o Do not apply large mechanical shocks or vibration to the probe. Do not sharply bend or strongly pull the probe cable.
- o The probe unit and tip are not highly heat resistant. Do not apply a soldering iron to a circuit close to the point where the probe is attached.

5.2 Voltage Measurement

To measure the AC portion of a signal which has DC superimposed on the AC component, set the vertical input AC/DC selector switches (13) and (20) in the AC position. To measure the DC component of a signal, set the switch in the DC position.

Before commencing voltage measurement, set the VARIABLE attenuator knobs (15) and (22) at the CAL'D position and calibrate the sensitivity to the value indicated by the VOLTS/DIV selector switches (16) and (23).

Apply the signal to be measured, display the signal with an appropriate amplitude on the screen, and determine the amplitude on the graticule. For DC voltage measurement, determine the shifted distance of the trace. The voltage can be determined as follows:

(1) When measured signal is directly applied to input terminal:

Voltage (V) = Deflection amplitude (DIV) × VOLTS/DIV

(2) When the 10:1 probe is used:

Voltage (V) = Deflection amplitude (DIV) × VOLTS/DIV × 10

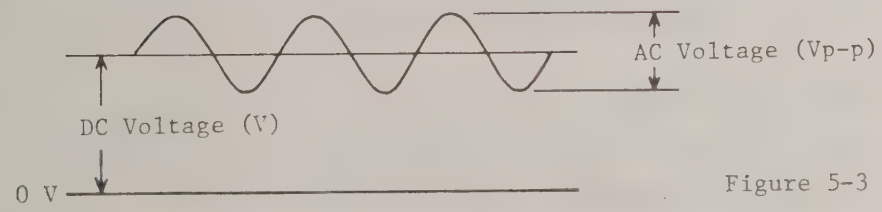


Figure 5-3

5.3 Current Measument (voltage drop method)

Connect a small resistor (R) in series in the circuit in which the current (I) to be measured flows and measure the voltage drop across the resistor with the oscilloscope. The current is known from Ohm's law as follows:

$$I = \frac{E}{R} \quad (A)$$

The resistance should be as small so possible it does not cause change to the measured signal source.

In the above method, currents from DC to high frequencies can be measured quite accurately. Note that the accuracy of the resistor reflects upon the measuring accuracy.

5.4 Time Measurement

Measurement of time interval

The time interval between any two points on the displayed waveform can be measured by setting the TIME/DIV VARIABLE knob (41) in the CAL'D position and referring to the indication of the TIME/DIV switch (39) .

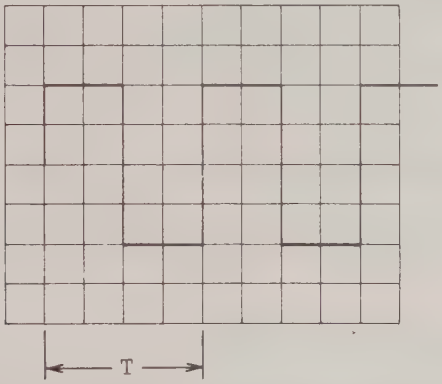


Figure 5-4

Time T (sec) = Indication of TIME DIV × Horizontal span (DIV)

When the sweep is magnified (×10 MAG (41) pulled), the time is 1/10 of the value determined as above.

5.5 Frequency Measurement

- Frequency measurement by determining time (T) per one cycle of the displayed waveform:

  Time T (period) is measured as explained in section 5.4 and the frequency is known by using the following formula.

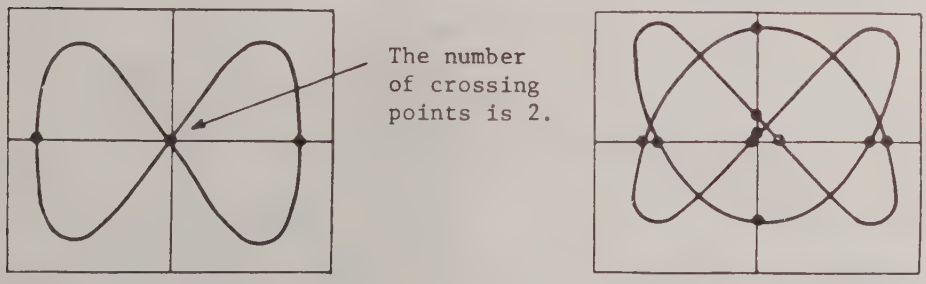
$$\text{Frequency } f \text{ (Hz)} = \frac{1}{\text{Period } T \text{ (sec)}}$$

- Frequency measurement with Lissajous figure (See Figure 5-5 and 5-6):

  Set the MODE switch (21) in the X-Y state so that the oscilloscope operates in the X-Y mode.

Apply to the X-axis a known frequency from a signal genetator (SG) and to the Y-axis the frequency to be measured. Adjust the required controls so that a pattern is displayed on the full surface of the CRT screen. Then adjust the frequency of the signal generator so that the displayed pattern becomes stationary as shown in Figure 5-4. From the displayed waveform, the unknown frequency can be calculated as follows:

$$\text{Unknown Frequency (Hz)} = \frac{\text{The number of crossing points over horizontal scale line}}{\text{The number of crossing points over vertical scale line}} \times \text{Frequency of signal generator (Hz)}$$



$\frac{4}{2} = \frac{2\ (H)}{1\ (V)}$ $\qquad$ $\frac{6}{4} = \frac{3\ (H)}{2\ (V)}$

Figure 5-5

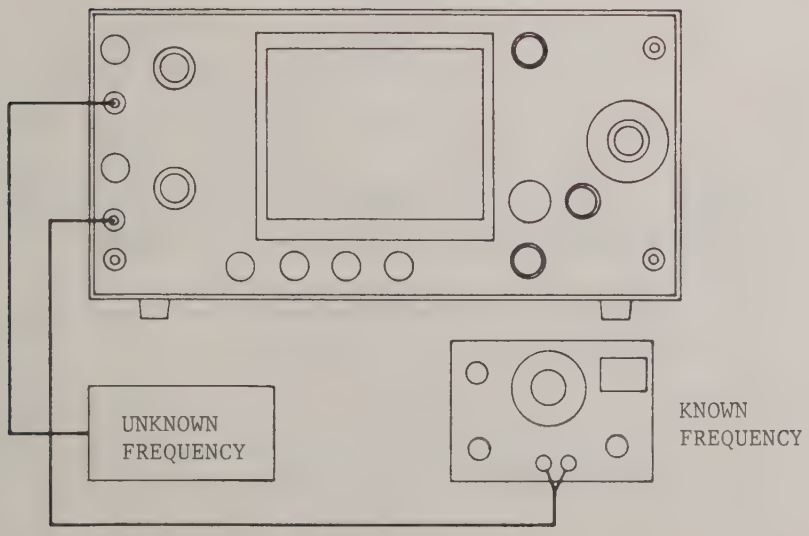


Figure 5-6

5.6 Measurement of Phase Difference

o Measurement of phase difference with Lissajous figure (See Figures 5-6, 5-7 and 5-8):

Operate the oscilloscope in the X-Y mode as explained in the paragraph for frequency measurement, and apply two signals of the same frequency (such as stereophonic signals) to the X and Y axes so that a Lissajous figure is displayed on the CRT screen. The phase difference between the two signals can be known by measuring the displayed waveform and employing the following equation:

$$\text{Phase difference } \theta = \sin^{-1} \frac{B}{A}$$

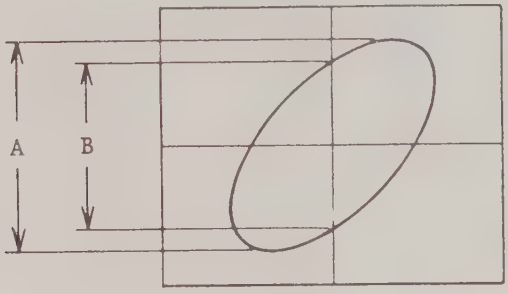


Figure 5-7

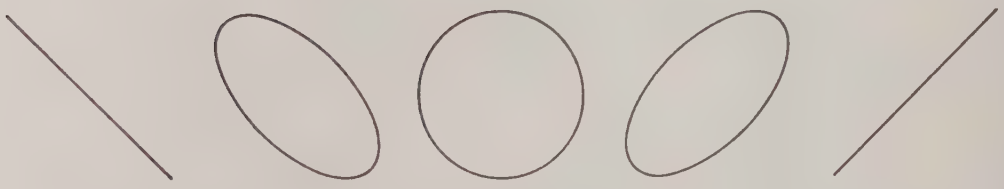


Figure 5-8

5.7 Characteristics of Pulse Waveform

A theoretically ideal pulse waveform is such that the signal changes instantaneously from one level to another, held in this level for a period of time and returns instantaneously to the original level. However, actual pulse waves are distorted. Nomenclature of distortions is given in Figure 5-9.

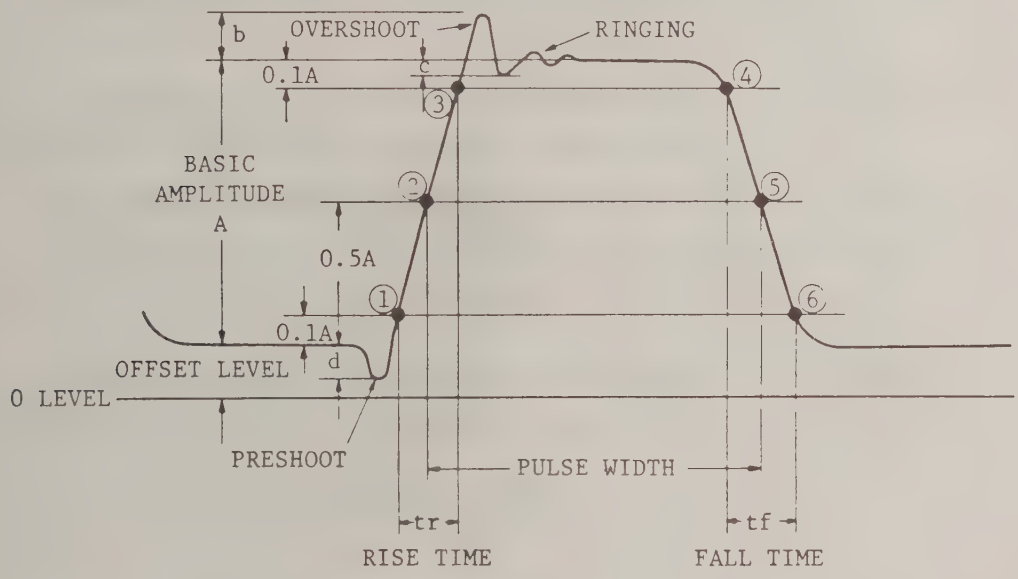


Figure 5-9

Pulse amplitude: Basic amplitude (A) of pulse

Pulse width: Time between points ② and ⑤ where signal amplitude is 50% of basic amplitude

Rise time: Time between 10% basic amplitude point ① and 90% basic amplitude point ③

Fall time: Time between 90% basic amplitude point ④ and 10% basic amplitude point ⑥

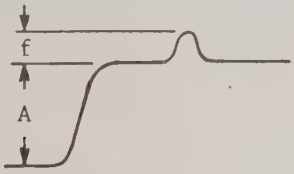
Overshoot: Amplitude of the first maximum excursion beyond basic amplitude. Expressed in terms of b/A × 100 (%)

Ringing: Oscillation which follows the first maximum excursion. Expressed in terms of c/A × 100 (%)

Preshoot: Amplitude change (rise or fall) which precedes rise up of main pulse. Expressed in terms of d/A × 10 (%)

Hole: Amplitude fall that occurs after rise up of main pulse. Expressed in terms of e/A × 100 (%)

Bump: Amplitude rise that occurs after rise up of main pulse. Expressed in terms of f/A × 100 (%)



(Refer to EIAJ MEA-27A or IEC PUB. 351-1.)

o Measurement of rise time:

The rise time of a pulse can be known by determining the value of t_r on the CRT screen in the method of "Time Measurement." It must be noted that t_r determined on the CRT screen includes the rise time of the oscilloscope itself. The closer the rise time of the oscilloscope (t_o) to the rise time of the measured pulse (t_n), the larger is the error introduced. To eliminate this error, calculation should be done as follows:

True rise time $t_n = \sqrt{(t_r)^2 - (t_o)^2}$

where, t_r: Rise time measured on CRT screen

t_o: Rise time of oscilloscope itself (approx. 3.5 nsec)

For example, when a pulse wave with a rise time of 10 nsec (about 3 times that of the oscilloscope) is measured on the CRT screen, the error is approximately 6%.

o Measurement of Sag

Pulse waveforms may have slanted sections as shown in Figure 5-10, in addition to those distortions mentioned in Figure 5-9. Slants are caused when the signal is amplified with an amplifier which has poor low-frequency characteristics, resulting from attenuation of low frequency components. The slanted section (d or d') is called "sag" and is calculated as follows:

$$\text{Sag} = \frac{d}{A} \quad (\text{or} \quad \frac{d'}{A'}) \times 100 \ (\%)$$

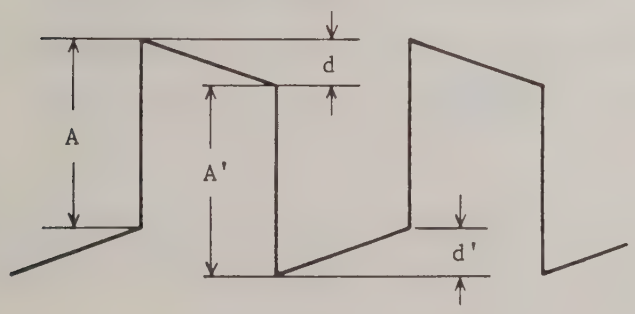


Figure 5-10

Note: If the AC-coupling mode is used for measurement of a low frequency pulse, sag is caused. For measurement of low frequency pulses, use always the DC-coupling mode.

5.8 10:1 Probe Compensation

Each time the 10:1 probes are used with the instrument, probe compensation should be checked and adjusted if necessary. A low capacitance screwdriver should be used. Use the following procedure for adjusting 10:1 probe compensation:

a. Connect the 10:1 probe to CH1 input (Figure 4-1 (21)).

b. Set the instrument controls as follows:

CH1 VOLTS/DIV	Figure 4-1 (23)	5 mV
A, B TIME/DIV	Figure 4-1 (39)	0.5 ms
CH1 input coupling	Figure 4-1 (20)	AC
Vertical MODE	Figure 4-1 (26)	CH1 depressed
COUPLING	Figure 4-1 (34)	AC
SOURCE	Figure 4-1 (35)	INT

c. Connect the 10:1 probe pickup to 200mV CAL(Vp-p) output (Figure 4-1 (43)).

d. Adjust CH1 POSITION (Figure 4-1 (24)) and HORIZ. POSITION (Figure 4-1 (44)) to display the top of at least complete positive pulse.

e. Adjust probe compensation (through hole in compensation box) for best flat top display. Refer to Figure 5-11.

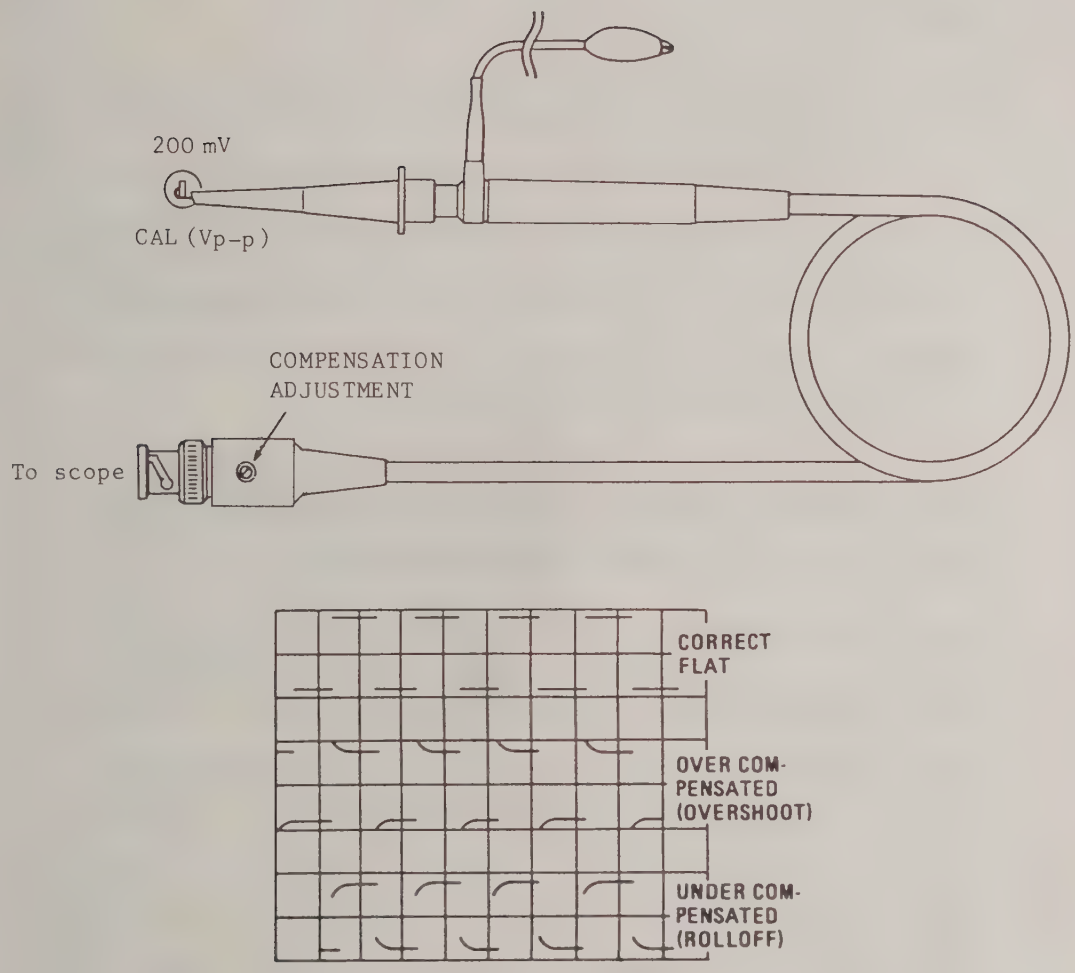


Figure 5-11. PROBE COMPENSATION

6. CIRCUIT DESCRIPTION

6.1 General

The overall circuit structure of the oscilloscope is as depicted with a block diagram in Figure 6-1. It is comprised of a vertical deflection circuit for moving the beam spot in the Y-axis direction on the CRT screen, a horizontal deflection circuit for moving the beam spot in the X-axis direction, a CRT circuit for operating the cathode-ray tube, a calibrator circuit for calibrating the instrument probe, and a power supply circuit for supplying powers to the various circuits of the instrument.

The vertical amplifier circuit has three mutually independent preamplifiers (CH1, CH2 and CH3), a vertical switching circuit, a delay line, and a vertical output amplifier.

Each of the preamplifiers amplifies or attenuates its input signal of several millivolts to several hundreds volts into a level suitable for handling by the subsequent stage. The conditioned vertical signals are sent to the vertical switching circuit. The trigger signals also are picked off at this stage.

The vertical switching circuit electronically switches the vertical signals received from the CH1, CH2 and CH3 preamplifiers and the CH4 and CH5 signals received from the A & B trigger generators. The switched signal is fed via the horizontal switching circuit and delay line circuit to the vertical output amplifier. The trigger signals also are switched and fed as internal trigger signals to the A & B trigger generators.

The vertical output amplifier amplifies the vertical signal, which is received through the delay line circuit, into a level of several volts to several tens volts for vertically deflecting the beam spot on the CRT screen.

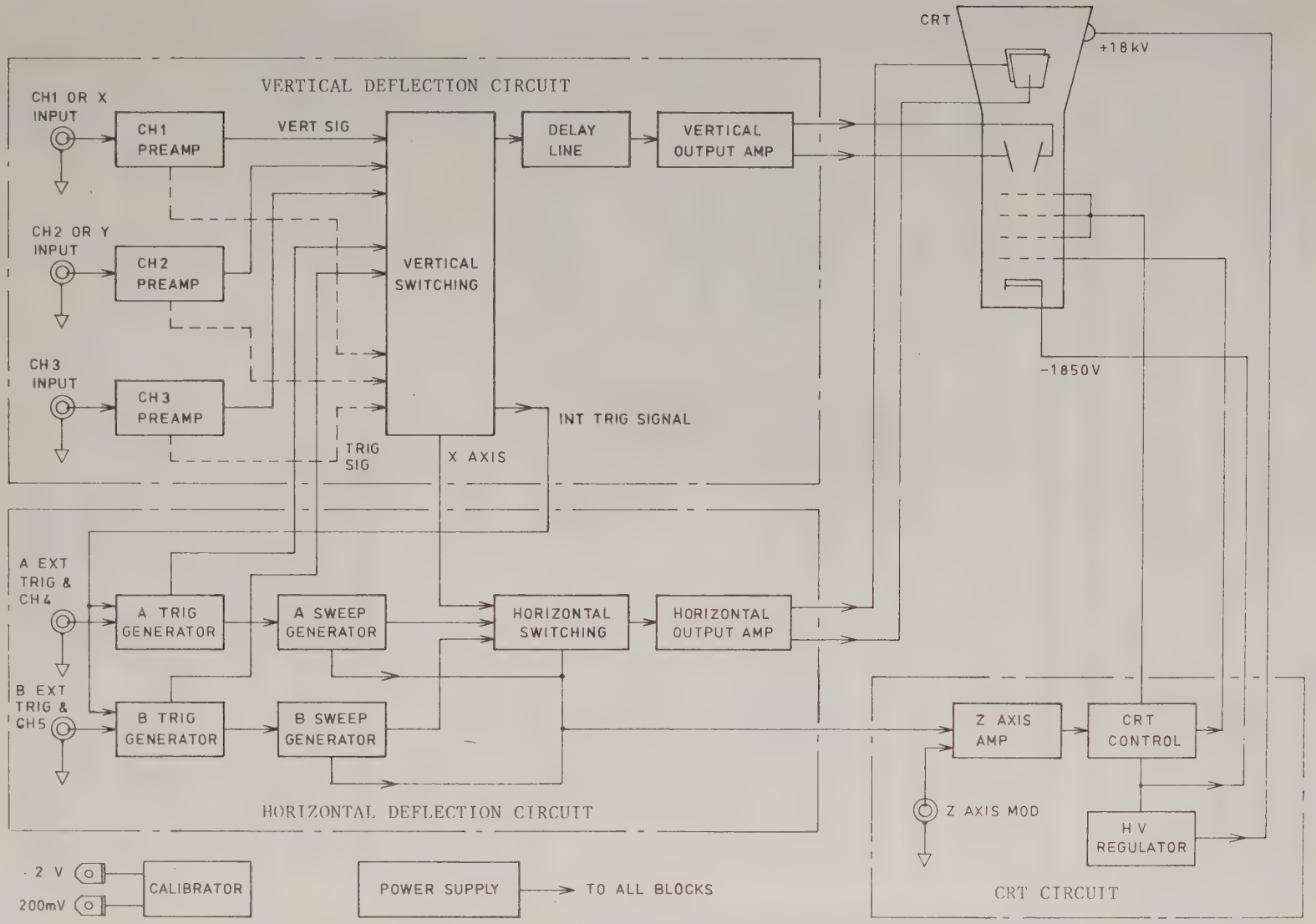

VERTICAL DEFLECTION CIRCUIT
CH1 OR X INPUT
CH1 PREAMP
VERT SIG
DELAY LINE
VERTICAL OUTPUT AMP
CH2 OR Y INPUT
CH2 PREAMP
VERTICAL SWITCHING
CH3 INPUT
CH3 PREAMP
TRIG SIG
X AXIS
INT TRIG SIGNAL
CRT
+18kV
-1850V
A EXT TRIG & CH4
A TRIG GENERATOR
A SWEEP GENERATOR
HORIZONTAL SWITCHING
HORIZONTAL OUTPUT AMP
B EXT TRIG & CH5
B TRIG GENERATOR
B SWEEP GENERATOR
Z AXIS AMP
CRT CONTROL
Z AXIS MOD
H V REGULATOR
HORIZONTAL DEFLECTION CIRCUIT
CRT CIRCUIT
.2 V
200mV
CALIBRATOR
POWER SUPPLY
TO ALL BLOCKS

Figure 6-1

The horizontal deflection circuit has mutually independent A and B trigger generators and sweep generators, a horizontal switching circuit, and a horizontal output amplifier.

The trigger generator receives the internal trigger signal from the vertical switching circuit or an external trigger signal from the EXT TRIG or CH4 or CH5 INPUT terminal and amplifies the signal and generates a trigger pulse signal.

The A sweep generator is driven by the trigger pulse signal of the A trigger generator and produces the A sawtooth signal. The sweep generator produces a sawtooth signal even when no trigger pulse is applied to it (the AUTO mode).

The B sweep generator produces the B sawtooth signal, being driven by the delayed sweep start signal produced with respect to the A sawtooth signal when in the delayed sweep mode. The B sweep generator can also be driven by the trigger pulse signal of the B trigger generator which follows the above delayed sweep start signal (the B TRIG'D mode).

The horizontal switching circuit electronically switches the sawtooth signals received from the A and B sweep generators and the CH1 & CH2 HOR signal received from the vertical switching circuit, and sends the resultant signal to the horizontal output amplifier.

The horizontal output amplifier amplifies the output signal of the horizontal switching circuit to a level of several volts to several tens volts in order to drive horizontally the beam spot on the CRT screen.

The CRT circuit is comprised of a high voltage generator (the HV regulator) to accelerate the electron beam emitted from the CRT cathode, a Z-axis amplifier to amplify the signal to blank out the return traces, and a CRT control circuit to operate the CRT tube in its optimal state.

The HV regulator provides a -1.8 kV voltage which is applied to the CRT cathode to accelerate the electrons emitted by it and a 18 kV voltage which is used as a post-acceleration voltage to accelerate further the electrons after passing the vertical and horizontal deflection plates.

The Z-axis amplifier amplifies the unblanking signals received from the A and B sweep generators and the trace intensity control signal to a level of several tens volts in order to be applied to the 1st grid (control grid) of the CRT via the CRT circuit.

The CRT circuit provides the various voltages for the CRT electrodes so that the CRT operates in an optimal state, displaying sharply-focussed less-distorted signal waveforms. It also conditions the signals received from the Z-axis amplifier and other circuit into levels suitable for application to the CRT.

6.2 Preamplifiers

The CH1 and CH2 preamplifiers amplify the signals of the CH1 (X-axis) and CH2 (Y-axis) input terminals, respectively. The CH3 preamplifier amplifies the signal applied to the CH3 or HOR input terminal. A detailed block diagram is shown in Figure 6-2.

- Input coupling switch:

The input coupling switch (S101, S201, S301-1, or S301-2) selects the input coupling mode for AC, GND, or DC. When the GND state is selected, the preamplifier input is isolated from the input terminal and is grounded so that the base line (0 level) on the CRT screen can be checked.

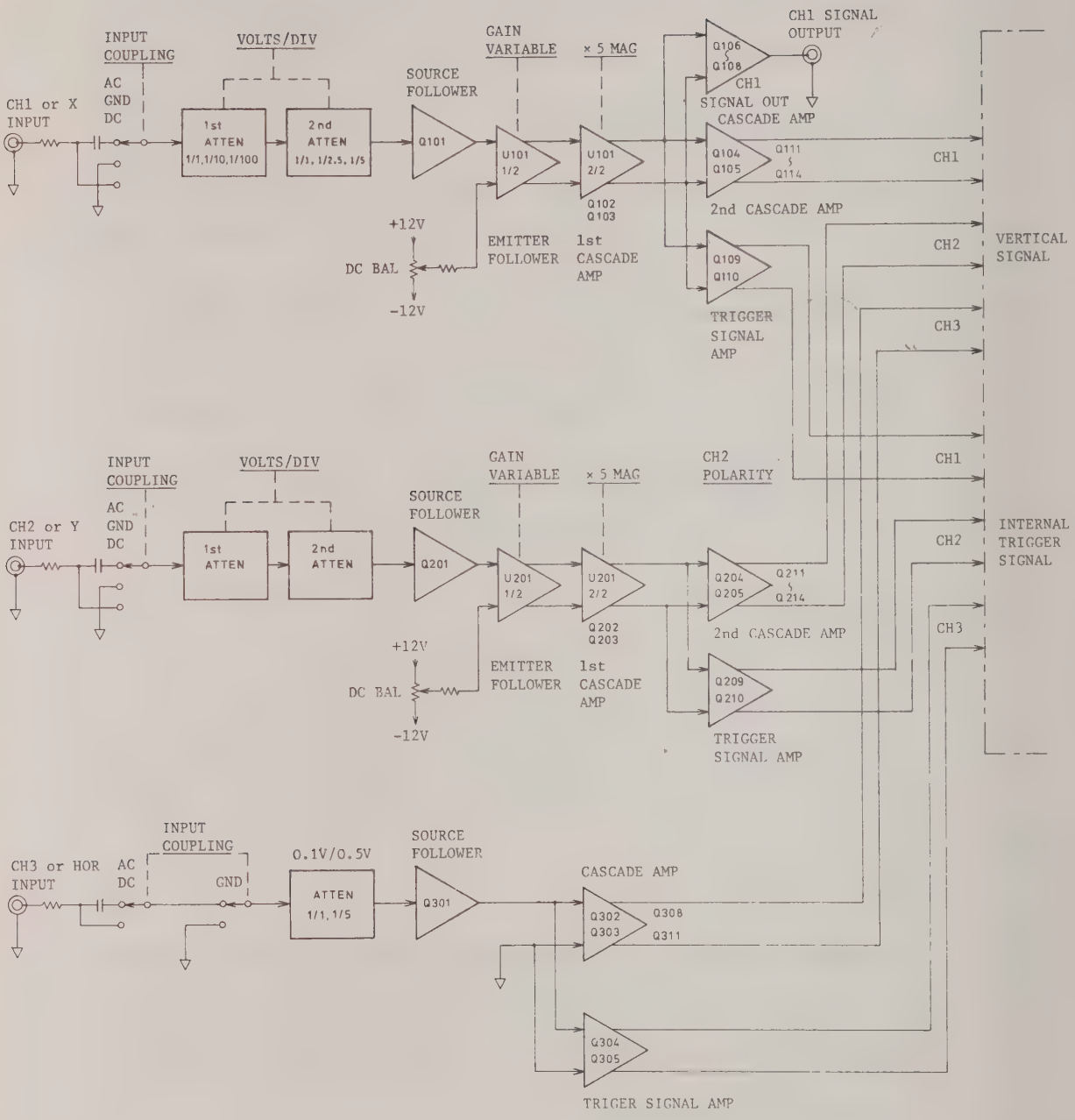

CH1 or X INPUT
INPUT COUPLING
AC
GND
DC
VOLTS/DIV
1st ATTEN 1/1,1/10,1/100
2nd ATTEN 1/1, 1/2.5, 1/5
SOURCE FOLLOWER
Q101
GAIN VARIABLE
U101 1/2
× 5 MAG
U101 2/2
Q102 Q103
+12V
DC BAL
-12V
EMITTER FOLLOWER
1st CASCADE AMP
CH1 SIGNAL OUTPUT
Q106 Q108
CH1 SIGNAL OUT CASCADE AMP
Q104 Q105
Q111 ~ Q114
2nd CASCADE AMP
Q109 Q110
TRIGGER SIGNAL AMP
CH1
CH2
CH3
VERTICAL SIGNAL
CH2 or Y INPUT
INPUT COUPLING
AC
GND
DC
VOLTS/DIV
1st ATTEN
2nd ATTEN
SOURCE FOLLOWER
Q201
GAIN VARIABLE
U201 1/2
× 5 MAG
U201 2/2
Q202 Q203
+12V
DC BAL
-12V
EMITTER FOLLOWER
1st CASCADE AMP
CH2 POLARITY
Q204 Q205
Q211 ~ Q214
2nd CASCADE AMP
Q209 Q210
TRIGGER SIGNAL AMP
CH1
CH2
CH3
INTERNAL TRIGGER SIGNAL
CH3 or HOR INPUT
INPUT COUPLING
AC
DC
GND
0.1V/0.5V
ATTEN 1/1, 1/5
SOURCE FOLLOWER
Q301
CASCADE AMP
Q302 Q303
Q308 Q311
Q304 Q305
TRIGER SIGNAL AMP

Figure 6-2

o Attenuators:

The CH1 or CH2 attenuator circuit consists of two attenuators: The 1st attenuator for 1/1, 1/10 and 1/100, and the 2nd attenuator for 1/1, 1/2.5, 1/5 and 1/10. By switching these attenuators with the VOLTS/DIV switch (S102/202), the signal can be attenuated for a total range of 1/1 to 1/250 in 11 steps. The attenuator circuit is so designed that its input impedance remains constant at 1 MΩ, 20 pF (±2 pF) even when combinations are changed.

The CH3 attenuator provides an attenuation ratio of 1/5, thereby providing two ranges of 0.1 V/DIV and 0.5 V/DIV.

o Impedance converter:

The impedance converter presents with its source follower (Q101/Q201/Q203) a high input impedance to prevent the loading effect on the high-impedance attenuator circuit and provides a low output impedance with its emitter follower (CH1 and CH2) to drive the 1st differential cascade amplifier of the next stage. In order to guard against thermal drift, the source follower employs a dual-FET package which houses two thermally-coupled elements for thermal drift compensation and the emitter follower employs two premium-grade thermally-coupled transistors.

o 1st differential cascade amplifier:

The 1st differential cascade amplifier is comprised of an emitter-connected differential current amplifier (U101-2/2, U202-2/2) and a current-to-voltage converter (Q102, 103/Q202, 203) which converts the differential collector output current of the differential current amplifier into a voltage signal. This amplifier also has the VARIABLE circuit for continuously-variable adjustment of the sensitivity between two adjoining vertical deflection sensitivity ranges selected by the VOLTS/DIV switch and the ×5 MAG switch for magnifying the vertical sensitivity by 5 times to realize the 1 mV/DIV sensitivity.

o VARIABLE circuit:

The VARIABLE circuit continuously-variably adjusts the vertical sensitivity by shunting with potentiometer RV103/RV203 a part of the collector current amplified by U101-2/2 or U201-2/2. Adjustment (attenuation) can be done with a ratio of 1/2.5 or over.

o × 5 MAG circuit:

The × 5 MAG function is to increase the vertical sensitivity by 5 times by switching the output load resistor of the 1st differential cascade amplifier to the value of 5 times of that when in the normal mode.

o 2nd differential cascade amplifier:

The 2nd differential cascade amplifier (Q104, 105, 111, 114, or Q204, 205, 211 - 214) amplifies the output of the emitter follower to a sufficient level for driving the vertical switching circuit. The grounded-base stage (Q111, 114/211 - 214) of this cascade amplifier has a function of preventing the switching signal of the vertical switching circuit from being returned to the preceding stage and mixed into the trigger signal or the signal of the CH1 signal output amplifier. For the CH2 signal, this amplifier also has a function of inverting its polarity. This polarity inverting function is accomplished by switching with the INV switch (S351-8) the base grounding stages of Q211/214 and Q212/213 to which the collector currents which have been current-amplified by Q204 and Q205 are fed in a crossing manner. Different from the case of the 1st differential cascade amplifier, the output signal of the 2nd differential cascade amplifier is fed directly in the form of the current signal to the diode gate of the vertical switching circuit. The current signal for vertical positioning of the trace on the CRT screen is added to the output current signal of the 2nd differential cascade amplifier, being controlled by potentiometer RV108/208 of the positioning circuit.

o CH1 signal output amplifier (CH1 only):

The CH1 signal output amplifier (Q106, 107, 108) amplifies the input signal of the CH1 (X INPUT) terminal by approximately 4 times (2 times when terminated with 50 ohms). The amplified signal is fed to the output terminal (J12) on the instrument rear panel in order to be monitored with a frequency counter or other measuring instrument.

6.3 Vertical Switching Circuit

The vertical switching circuit is comprised of a vertical signal switching circuit which electronically switches the vertical signals received from the CH1, CH2 and CH3 preamplifiers and the CH4 and CH5 signals received from the A & B TRIG generators, an internal trigger signal switching circuit which electronically switches the trigger signals, and a switching logic circuit which controls these switching circuits.

The vertical signal switching circuit is, as shown in Figure 6-3, comprised of a diode gate circuit, an ADD BAL and buffer circuit which switches the vertical signals with the signal received from the switching logic circuit, and a switching buffer circuit which receives the signal from the diode gate.

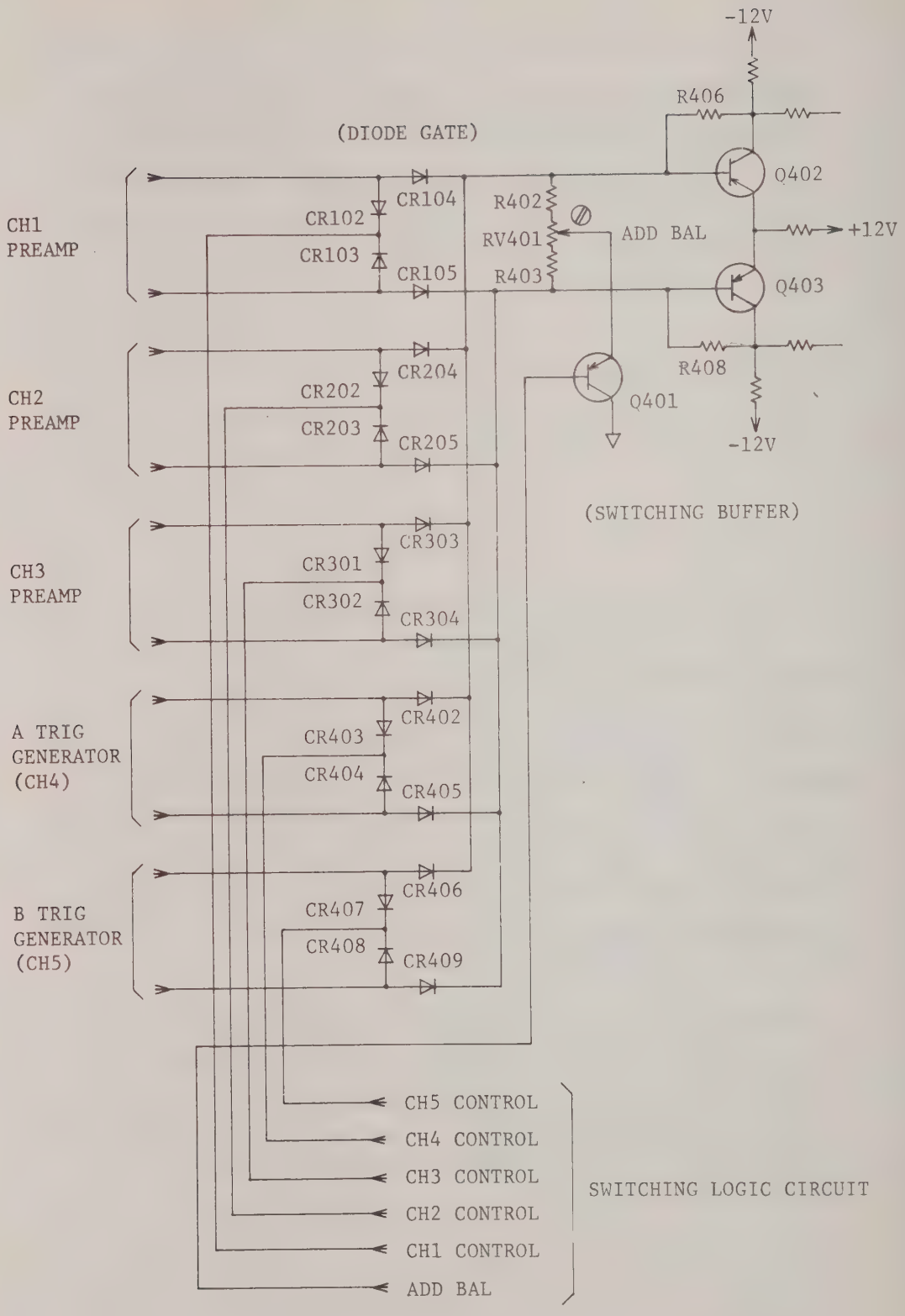

-12V
R406
(DIODE GATE)
Q402
CR104
R402
CR102
RV401
ADD BAL
+12V
CH1
PREAMP
CR103
CR105
R403
Q403
CR204
R408
CH2
PREAMP
CR202
Q401
CR203
CR205
-12V
(SWITCHING BUFFER)
CR303
CR301
CH3
PREAMP
CR302
CR304
CR402
A TRIG
GENERATOR
(CH4)
CR403
CR404
CR405
CR406
B TRIG
GENERATOR
(CH5)
CR407
CR408
CR409
CH5 CONTROL
CH4 CONTROL
CH3 CONTROL
SWITCHING LOGIC CIRCUIT
CH2 CONTROL
CH1 CONTROL
ADD BAL

Figure 6-3

o Diode gate circuit:

The diode gate circuit (CR102 - 105, CR202 - 205, CR301 - 304, CR402 - 409) selects the CH1 - CH5 signals being controlled by the signal of the switching logic circuit according to the mode selected by the VERT MODE switch (S351).

For example, when the VERT MODE switch is set at CH1, the CH1 control signal becomes the Hi state and the CH2 to CH5 control signals become Lo state. Consequently the output signal of the CH1 preamplifier is fed through CR104 and CR105 to the switching buffer circuit consisting of Q402 and Q403. The signals of the other channels are fed through respective diodes CR202/203, CR301/302, CR403/404 and CR407/408 to the control circuit. Thus, the signal of CH1 alone is fed to the switching buffer circuit and the signals of the remaining channels are blocked.

o ADD BAL circuit:

When the ADD mode is selected by the VERT MODE switch, the control signals of both CH1 and CH2 becomes the Hi state, the signals of the CH1 and CH2 preamplifiers are fed through CR104/105 and CR204/205 to the switching buffer circuit, and the two signals are fed as their sum signal to the output circuit. The function of the ADD BAL circuit is to compensate for the DC balance shift caused by the above addition operation, with its ADD BAL control (semi-fixed potentiometer RV401).

o Internal trigger switching circuit:

The internal trigger switching circuit directly controls, with the control signal from the switching logic circuit, the diode gate circuit (CR351 - 362) which is similar to the vertical signal switching circuit. It receives with its switching buffer (Q351/352) the trigger signal which has passed the diode gate circuit and feeds the signal to the internal trigger output amplifier. The internal trigger output amplifier (Q353/354)

coverts the output signal of the switching circuit into a low impedance signal which is delivered as the internal trigger signal via connector P-31.

o Switching logic circuit:

The switching logic circuit is comprised of a vertical switching logic circuit which controls the vertical switching circuit and an internal trigger switching logic circuit which controls the internal trigger switching circuit.

The vertical switching logic circuit is comprised of a ring counter which is consisting of three flip-flops (U307, U309-2/2) with preset/clear terminals and a code converter (U304, U305) which receives the ring counter output and generates control signals for individual channels. Switching can be done for any combination of channels by turning on and off the preset/reset terminals of the ring counter. The code-converted control signal is fed to the internal trigger switching logic circuit.

The internal trigger switching logic circuit controls the internal trigger switching circuit by switching with IC U301 the control signal selected by the INT TRIG switch (S301) and the control signal received from the vertical switching logic circuit. This relationship is shown in the following table.

INT TRIG \ MODE	CH1	ADD	CH2	CH3	TRIG VIEW	
					CH4	CH5
CH1	Triggered by CH1					
CH2	Triggered by CH2					
CH3	Triggered by CH3					
ALT	Trig'd by CH1	Trig'd by CH1	Trig'd by CH2	Trig'd by CH3	(Trig'd by CH1)	(Trig'd by CH1)

The items enclosed in the parentheses are for the case of TRIG VIEW (INT TRIG).

6.4 Delay Line Circuit

The vertical input signal is fed via the vertical switching circuit to the bandwidth filter circuit and then to the delay line drive circuit.

The bandwidth filter circuit consists of a CR filter (R412/C405 and R414/C406) and a transistor (Q404) which turns on and off the filter. With the control signal of the BW LIMIT switch (S351-9), bandwidth can be selected between 20 MHz and full band.

The vertical signal which has passed the bandwidth filter is amplified by the delay line drive circuit (Q405, Q406). The delay line drive circuit drives the delay line, with a matched output impedance.

The delay line is used to prevent the trigger point of the signal from being lost from being displayed on the screen due to time lag in the horizontal deflection circuits or the Z-axis amplifier circuits. For the delay line, this oscilloscope employs a delay cable which provides a delay time of approximately 90 nanoseconds. The vertical signal which has passed the delay line is fed to the vertical output amplifier.

6.5 Vertical Output Amplifier

The vertical output amplifier is comprised of a delay line receiver which receives the output signal of the delay line with a matched impedance, an A & B trace separation circuit which positions the B sweep waveform when in the ALT mode, an emitter follower circuit which converts the output of the delay line receiver into a sufficiently low impedance to drive the final cascade amplifier which drives the vertical deflection plates of the CRT, and an X-Y alignment circuit which adjusts the right-angle feature of the displayed axes. A schematic diagram of the vertical output amplifier is shown in Figure 6-4.

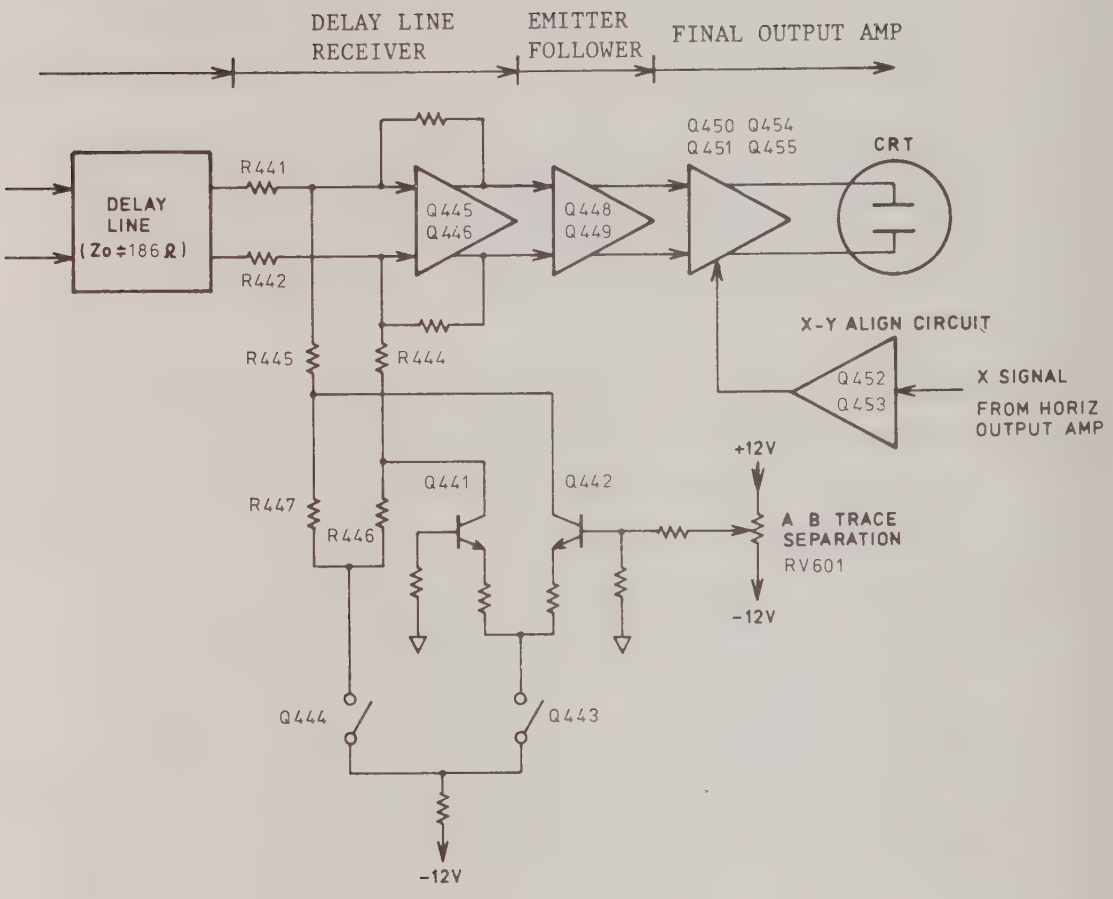

DELAY LINE RECEIVER
EMITTER FOLLOWER
FINAL OUTPUT AMP
DELAY LINE (Zo≒186Ω)
R441
R442
Q445 Q446
Q448 Q449
Q450 Q454 Q451 Q455
CRT
X-Y ALIGN CIRCUIT
Q452 Q453
X SIGNAL FROM HORIZ OUTPUT AMP
R445
R444
R447
R446
Q441
Q442
+12V
A B TRACE SEPARATION RV601
-12V
Q444
Q443
-12V

Figure 6-4

o Delay line receiver circuit:

The delay line receiver circuit (Q445, 446) is a low input impedance negative feedback amplifier which, with its input resistors R441 and R442, provides impedance matching with the characteristic impedance (Zo ≒ 186 ohms) of the delay line. With this low input impedance, the A & B trace separation circuit is connected in parallel.

o A & B trace separation circuit:

The A & B trace separation circuit vertically positions the trace by varying the currents which flow through resistors R444 and R445 from the input of the delay line receiver, as shown in Figure 6-4. In order to prevent intrusion of switching pulses, this circuit has a balanced current circuit (R446 and R447) and an unbalanced current circuit (Q441 and Q442), and these circuits are switched by the transistor switching circuit (Q443, 444). Balancing of the currents which flow in Q441 and Q442 is adjustable with the A & B TRACE SEPARATION potentiometer (RV601).

o Emitter follower:

The emitter follower (Q448, 449) converts the output signal of the delay line receiver into a low impedance to drive the final cascade amplifier. In order to suppress parasitic oscillations, the signal is fed from the emitters of Q448 and Q449 to the bases of Q450 and Q451 through R465 and R468.

o Final cascade amplifier:

The final cascade amplifier is a differential cascade amplifier comprising of a current amplification stage (Q450, 451) which has a high f_T in order to provide a sufficient output voltage to drive the vertical deflection plates of the CRT, and a voltage converter stage (Q454, 455) which employs high-voltage-type high-frequency transistors.

The right-angle compensation current signal of the X-Y alignment circuit is added to the output of the above current amplifier in order to maintain the perpendicularity of the axes on the CRT screen.

o X-Y alignment circuit:

The X-Y alignment circuit (Q452, 453) is a differential amplifier which provides a current signal to compensate for right-angle error of the axes on the CRT screen. This amplifier receives part of the horizontal deflection signal from the horizontal output amplifier and converts it into a perpendicularity compensation current signal, which is applied to the emitters of Q454 and Q455. The polarity and amount of the perpendicularity compensation current signal are adjustable with the X-Y ALIGN potentiometer (RV455).

6.6 A and B Trigger Generators

The A trigger generator is comprised of a trigger pulse generator circuit which produces a trigger pulse signal for driving the A (main) sweep generator and an AUTO circuit which produces a free-run signal for automatic sweep operation when the trigger signal is asynchronized or no trigger signal is applied. The B trigger generator produces a trigger pulse for driving the B (delayed) sweep generator when in the B TRIG'D mode.

A Trigger Generator:

As shown in Figure 6-5, the trigger pulse generator circuit of the A trigger generator is comprised of a source switch which selects a trigger signal source, a coupling switch which selects a coupling mode in conformity with the nature of the trigger signal source, an impedance converter circuit which converts the high-impedance trigger source signal into a low-impedance signal with which to drive the level comparator circuit which controls

the start point (triggered point) of the signal waveform displayed on the CRT screen, a TV synchronization separator circuit which picks off the synchronization signal from the TV video signal, and Schmitt trigger circuits which convert the output signals of the level comparator circuit and TV synchronization signal separator circuit into TTL level signals.

o Source switch:

The source switch (S501) selects the internal trigger signal fed from P-69, the line trigger signal fed from R1212, the the external trigger signal fed from J4, or the signal fed from F-4 and attenuated by a factor of 1/5 into the EXT ÷ 5 TRIG signal. The selected signal is fed to the coupling switch.

o Coupling switch:

The coupling switch (S502) selects the coupling mode. Switch S502-2 selects the DC mode for direct coupling of the signal fed from S501, the AC mode for discarding the DC component, or the HF REJ mode for coupling via a low-pass filter. Switch S502-1 selects ON or OFF of the TV synchronization signal separator circuit which facilitates observation of a TV video signal.

o Impedance converter:

The impedance converter is a temperature-compensated-type cathode follower (Q501) with dual FETs. It converts the trigger signal selected by the source switch and coupling switch into a low-impedance signal. The impedance is lowered further by the emitter follower of U501 and then the signal is fed to drive the level comparator circuit.

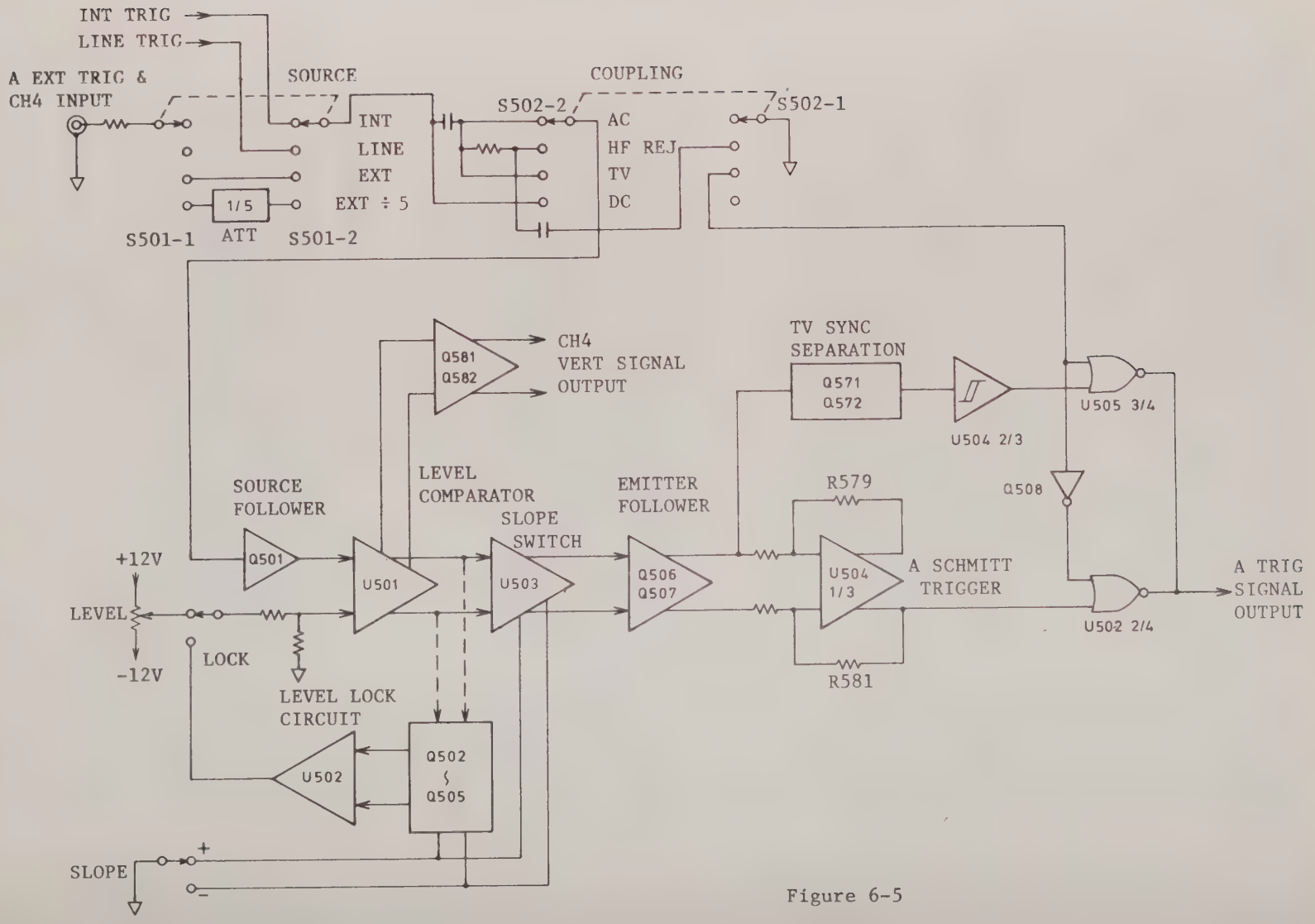

INT TRIG
LINE TRIG
A EXT TRIG &
CH4 INPUT
SOURCE
INT
LINE
EXT
EXT ÷ 5
1/5
ATT
S501-1
S501-2
COUPLING
S502-2
S502-1
AC
HF REJ
TV
DC
Q581
Q582
CH4
VERT SIGNAL
OUTPUT
TV SYNC
SEPARATION
Q571
Q572
U504 2/3
U505 3/4
Q508
R579
SOURCE
FOLLOWER
LEVEL
COMPARATOR
SLOPE
SWITCH
EMITTER
FOLLOWER
+12V
LEVEL
-12V
Q501
U501
U503
Q506
Q507
U504
1/3
A SCHMITT
TRIGGER
A TRIG
SIGNAL
OUTPUT
U502 2/4
R581
LOCK
LEVEL LOCK
CIRCUIT
U502
Q502
≀
Q505
SLOPE
+
-

Figure 6-5

o Level comparator:

The level comparator is a differential cascade amplifier (U501, U503) which adjusts the rise up portion (or the fall down portion) of the comparator output signal by applying to U501 No. 9 of the current amplifier stage the trigger source signal from the impedance converter circuit and adding to U501 No. 8 the comparator level signal from the LEVEL control potentiometer (R501). In this case, if switch S503 which is linked to the LEVEL control potentiometer is locked, the comarator level signal is applied to U501 No. 8 from the level lock circuit and the trigger point is fixed at the center amplitude of the trigger source signal. The level lock circuit amplifies with its error amplifier the error signal detected by Q502 - Q505 and feeds back the signal so that the center level of the comparator output signal becomes the Schmitt level of the Schmitt trigger circuit.

The SLOPE switch (S505) selects a slope by switching the voltage converter stage of the cascade amplifier by changing polarity of U503.

The output signal of the cascade amplifier is fed via the impedance converter (Q506, 507) to the TV synchronization signal separator circuit and the regular (non-TV) Schmitt circuits.

o TV synchronization signal separator circuit:

The TV synchronization signal separator circuit (Q571) is a base leak type circuit and picks off the synchronization signal from a video signal. When in the TV.H synchronization mode, the output signal is directly fed to the TV SYNC Schmitt trigger circuit U504 2/3. When in the TV.V synchronization mode, the circuit produces a TV.V synchronization signal by grounding with transistor Q502 the capacitors (C502, 507) which is connected so that the input resistance of the Schmitt

trigger circuit becomes the integration resistance of the integration circuit. Switching between TV.V and TV.H is done being linked to the TIME/DIV switch within the following ranges:

TV.V: 0.5 sec - 0.1 msec ranges
TV.H: 50 usec - 20 nsec ranges

o A TRIG Schmitt circuit:

The A TRIG Schmitt circuit is a differential type circuit which generates a hysteresis voltage by applying a feedback signal with R579/581 to the ECL line receiver of U504 1/3. The output of the Schmitt circuit drives the A SWEEP generator and AUTO circuit via the NORM/TV switching circuit.

o AUTO circuit:

The AUTO circuit converts with its pulse converter (U505 2/4, 4/4, Q573) the high-speed pulse signal of the trigger pulse generator into a low-speed pulse signal which is applied to the CH1, CH2 and CH3 stable multivibrators (702 1/2, 2/2, U701 2/2) to generate the CH1, CH2 and CH3 AUTO signals. With the AUTO switching pulse signal received from the vertical switching circuit, the CH1, CH2 and CH3 signals are switched by the AUTO signal switching circuit (U703). The switched AUTO signal is conditioned for waveform-shaping by the Schmitt circuit (U504 3/3) to drive the A sweep generator and the TRIG'D LED lamp.

B Trigger Generator

The B trigger generator is identical with the A trigger generator except that the former has no AUTO circuit since no such circuit is required for its operation.

6.7 A and B Sweep Generators

The A sweep generator produces the sawtooth signal for the main sweep (A sweep) of this oscilloscope. The B sweep generator produces the sawtooth signal for magnification in the time axis direction the waveform displayed on the main sweep or for display with a certain time delay (delayed sweep or B sweep).

The A sweep generator consists of the A sweep gate circuit which receives the trigger signal from the A trigger generator and produces the sweep gate signal for starting sweeps, the sweep start comparator which maintains stably the sweep start point, the A sawtooth sweep generator which produces a sawtooth wave in conformity with the time constant selected by the TIME/DIV switch, the sweep length circuit which controls the length of sweeps, the hold off circuit which controls the sweep return period and pause period, and the A sweep gate enable circuit which controls the sweep gate circuit in conformity with the AUTO, NORM or SINGLE mode as selected by the MODE switch for the signals of the above control circuits.

o A sweep gate:

The A sweep gate circuit employs a flip-flop ECL IC with reset/clear function. The trigger pulse of the A trigger generator is applied to the CLOCK (No. 11) terminal, the enable signal of the A sweep gate enable circuit to the SET (No. 12) terminal, and the enable signal and AUTO signal of the AUTO circuit to the RESET (No. 13) terminal through the NOR gate circuit. The Q (No. 14) terminal output is applied as the unblanking signal to the Z-axis amplifier and the $\overline{Q}$ (No. 15) terminal output is fed to the sweep start comparator circuit and becomes the A sweep gate signal. Even when no trigger pulse signal is applied to the CLOCK terminal, the $\overline{Q}$ output can be made the low state with the AUTO signal of the RESET terminal so that the A sweep gate signal is generated and the circuit operates in the free-run mode.

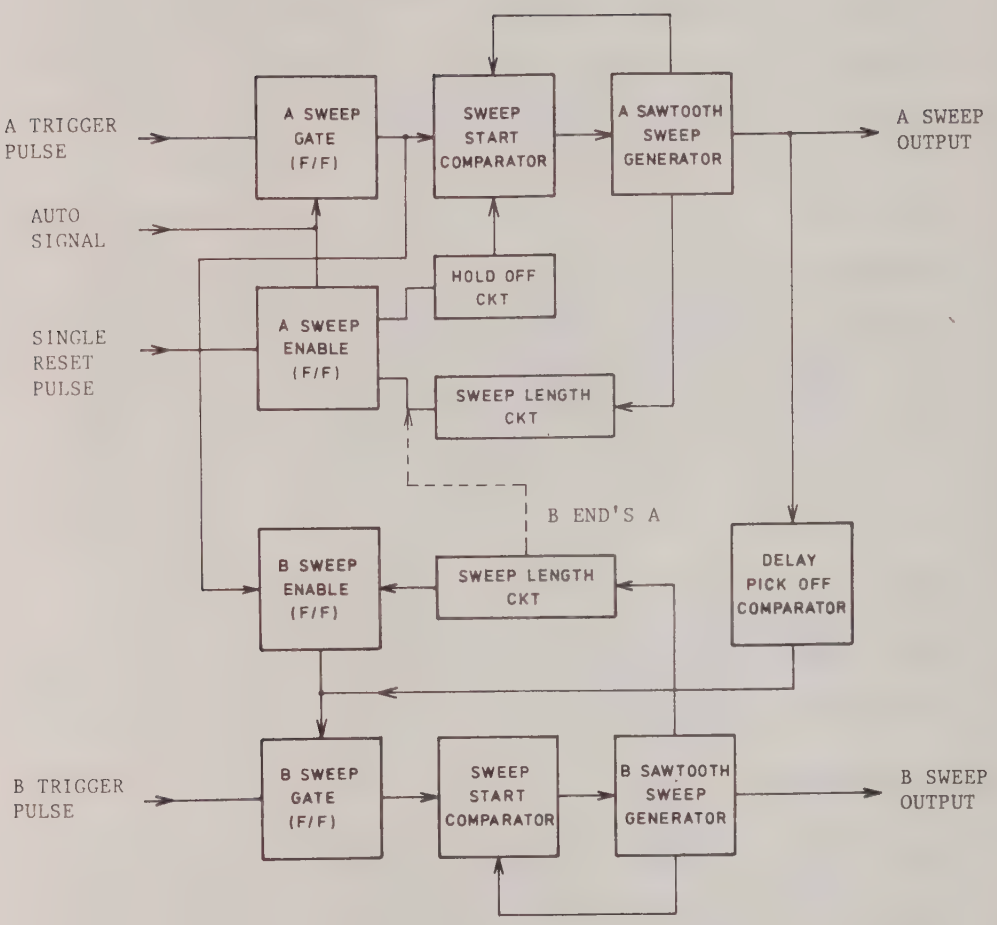

A TRIGGER PULSE
A SWEEP GATE (F/F)
SWEEP START COMPARATOR
A SAWTOOTH SWEEP GENERATOR
A SWEEP OUTPUT
AUTO SIGNAL
HOLD OFF CKT
SINGLE RESET PULSE
A SWEEP ENABLE (F/F)
SWEEP LENGTH CKT
B END'S A
B SWEEP ENABLE (F/F)
SWEEP LENGTH CKT
DELAY PICK OFF COMPARATOR
B TRIGGER PULSE
B SWEEP GATE (F/F)
SWEEP START COMPARATOR
B SAWTOOTH SWEEP GENERATOR
B SWEEP OUTPUT

Figure 6-6 -

o Sweep start comparator:

The sweep start comparator (Q802, 803) is a differential amplifier which lets the sweep gate signal pass and maintains constant the sweep start level. A start reference level identical with the B sweep start level is applied to one of the inputs, the Miller integrator output signal is applied to the other input, and the difference between the two signals is compensated for.

o A sawtooth generator:

The A sawtooth generator is comprised of a gate transistor amplifier, a Miller integrator, an integration time constant switching circuit, and a logic circuit which controls the switching circuit. The gate transistor amplifier (Q810) controls the Miller integrator circuit in such manner that the start level control signal and sweep gate signal of the sweep start comparator do not affect the integration time constant. The Miller integrator (Q809, Q811, 812) produces a sawtooth signal with the time constant selected by the integration time constant selector circuit. The integration time constant selector circuit selects integration capacitor C811/C812 with U802 1/4, 2/4. For integration current, R833 - 836 are selected by Q818 - 821 and R828 - 830 by CR811 - 813. The logic circuit selects an integration capacitor and a resistor in conformity with the range selected by the TIME/DIV switch (S801) in order to control the integration time constant selector circuit.

o Sweep length circuit:

The sweep length circuit divides with its voltage divider (R731, RV701, R732) the output of the A sweep generator, shapes the waveform with its Schmitt circuit (U706 2/3), and produces the length signal. The B END A signal is added to the signal of No. 5 pin of U704.

o Holdoff circuit:

The holdoff circuit generates a holdoff (pause) time signal proportional to the sweep time by producing a triangular wave with the Miller integrator (Q807) and making use of the fall time of the triangular wave. The integrator, with its Q805 and Q806, selects the time constant in accordance with the integration output voltage in order to cover a wide time range. The output signal of the Miller integrator is detected by Q804 and shaped by the Schmitt circuit (U706 3/3) into a holdoff signal. The trigger pulse is fed to the reference input of the Schmitt circuit via C708 in order to suppress jitter which could be produced when in high speed sweep.

o A sweep gate enable circuit:

The A sweep gate enable circuit employs the flip-flop IC (U704 1/2) which makes up a pair with the A sweep gate circuit. The holdoff signal is applied to the RESET (No. 4) terminal, the length signal is applied to the SET (No. 5) terminal, and the enable signal is delivered from the Q (No. 2) terminal. This enable signal resets or sets the A sweep gate circuit. When in the NORM sweep mode, the output signal of the AUTO circuit is blocked and, if no trigger signal is applied, the circuit is in the ready state. When in the SINGLE sweep mode, the holdoff circuit remains idle and a one-shot sweep is effected by the reset signal applied from the CLOCK (No. 6) terminal.

The basic structure of the B sweep generator is identical with that of the A sweep generator. It consists of the B sweep gate, sweep start comparator, B sawtooth generator, sweep length circuit, B sweep enable circuit, and delay pickoff comparator. The B sweep generator requires no holdoff circuit because it operates only during the period the A sweep generator is in the sweep operation. Instead of the holdoff signal, the A sweep gate signal sets the B sweep enable circuit to the enable state.

o Delay pickoff comparator:

The delay pickoff comparator (Q704 - 707) employs a dual FET (Q706) to obtain a certain time relationship as set by the delay time multiplication potentiometer (RV705) with respect to the A sweep signal. The comparator compares the A sweep output signal (sawtooth waveform) with the voltage set by RV705, generates a delayed sweep start signal, and sets the B sweep gate circuit to start the B sweep signal. When in the B TRIG'D mode, the B sweep gate circuit is not set directly with this delayed sweep start signal but the RESET (No. 13) terminal is set in the low state and the B sweep signal is started as driven by the trigger pulse of the B trigger generator.

6.8 Horizontal Switching Circuit

The horizontal switching circuit is comprised of a switching buffer circuit which prevents switching distortion from being sent to the sweep circuit of the preceding stage, a display switching circuit which electronically switches the A and B sweep signals, a × 10 MAG circuit which magnifies the sweep signal by 10 times, and a horizontal mode switching circuit which selects either CH1 or CH3 signal for the horizontal axis.

o Switching buffer circuit:

The switching buffer circuit is of a grounded-base-type amplifier. Transistor Q1001 is for buffer-amplification of the A sweep signal, transistor Q1002 for the B sweep signal.

o Display switching circuit:

The display switch circuit has a diode switching circuit (CR1002, 1003) which turns on and off the A and B sweep signals by controlling the emitter currents of transistors Q1003 and Q1004. The on-off actions of diodes CR1002 and CR1003 are controlled by U1002 1/2 IC as dictated by the DISPLAY switch (S1001). U1002 2/2 IC generates

the vertical ALT switching pulse signal. The switched sweep signal is fed to the ×10 MAG circuit, which is used also to drive the horizontal mode switching circuit.

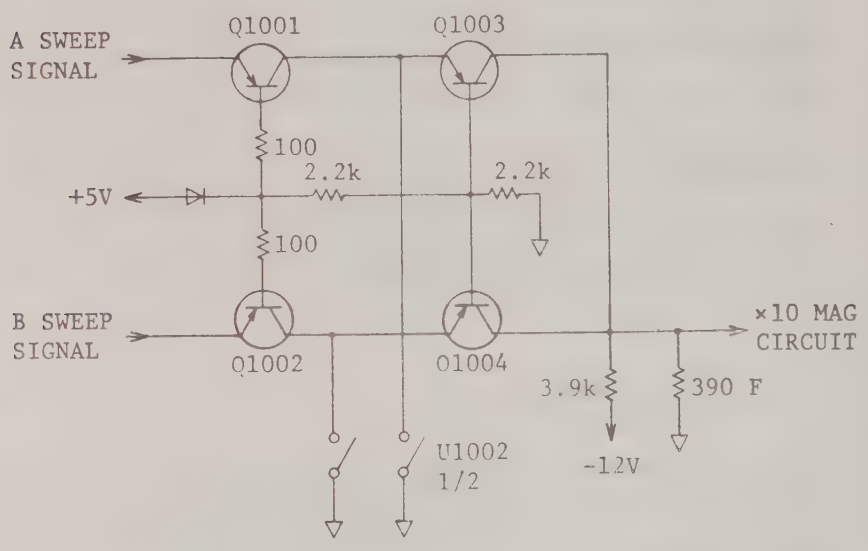


Figure 6-7

o ×10 MAG circuit:

The ×10 MAG circuit converts the sweep signal selected by the display switching circuit into a balanced signal with its transistors Q1008 and Q1009, and it also synthesizes the ↔ POSITION signal.

The ×10 MAG circuit magnifies the gain by 10 times by selecting the emitter coupling resistors of Q1008 and Q1009 with switching transistors Q1006 and Q1007.

o Horizontal mode switching circuit:

The horizontal mode switching circuit (Q1010 - 1013) is a solid-state switching circuit made up of transistors with their collectors connected together. Transistors Q1010 and Q1011 switches

the sweep signal received from the ×10 MAG circuit; transistors Q1012 and Q1013 switches the CH3 HORIZONTAL signal received from P-57.

6.9 Horizontal Output Amplifier

The horizontal output amplifier consists of a drive amplifier which converts and conditions the above signal into a balanced signal and drives the output amplifier, and an output amplifier which drives the horizontal deflection plates of the CRT.

- o Drive amplifier:

The drive amplifier (Q1051 - 1054) limits the amplitude of the horizontal signal received from the horizontal switching circuit and drives the output amplifier via the diode limiter. Also, it delivers the signal as an X-Y alignment signal of the collector of Q1052 to the vertical output amplifier.

- o Output amplifier:

The output amplifier (Q1057 - 1064) is comprised of feedback-type SEPP amplifiers symmetrical for right and left which provide sufficient speed and output voltage for driving the horizontal deflection plates of the CRT. The signal current-amplified by Q1057/1059 and Q1058/1060 is converted into a voltage signal by Q1061/1063 and Q1062/1064 to obtain a sufficiently high gain and a sufficiently low output impedance. By means of negative feedback resistor R1077/R1080 a stable gain and wide and flat frequency response are attained.

6.10 Z-axis Amplifier

The Z-axis amplifier is comprised of an input circuit and an output amplifier. The input circuit merges the unblanking signals of the A and B sweep generators, the external intensity modulation signal applied through the Z-axis input terminal, the

B intensity control signal, and the overall intensity control signal. The output amplifier amplifies the merged signal into a sufficient level for driving the G1 grid of CRT.

o Input circuit:

The input circuit produces the main unblanking signal by merging through the gate circuit (U708 3/4 4/4) the unblanking signals of the A and B sweep generators and the A intensity gate signal of the horizontal switching circuit. The input circuit also adds to the above merged signal, as selected by the display switch (S1001) and the vertical mode switch (S351), the B intensity control signal, the chopped blanking signal, the external intensity modulation signal applied via the X-axis input terminal, and the overall intensity control signal. The resultant compound signal is fed to the output amplifier.

o Output amplifier:

The output amplifier amplifies the above compound signal to several tens volts. It is of a feedback-type SEPP circuit (Q1149 - 1156) similar to that of the horizontal output amplifier. This amplifier also generates a linear focus signal which is in the inverted phase of the unblanking signal. The amplified unblanking output signal and linear focus signal are fed to the G1 and P1 of the cathode-ray tube through the CRT circuit to drive the intensity and focus of the displayed waveform.

6.11 CRT Control Circuit

The CRT control circuit is comprised of a DC regeneration circuit which converts the linear focus signal and the unblanking output signal of the Z-axis amplifier into the operating-voltage signals of the CRT in order to be applied to the focus electrode and G1 electrode of the CRT, semi-fixed potentiometers HALATION (RV1104), ASTIG (RV1103), GEOMETRY (RV1105) and SUB-FOCUS (RV1102), a trace rotation circuit for adjusting the trace direction in parallel

with the horizontal graticule lines, and an illumination circuit for illuminating the graticule.

- o DC regeneration circuit:

  The DC regeneration circuit converts the linear focus signal and unblanking signal of several tens to several hundreds volts into AC signals with the switching signal of the DC-DC converter circuit, and then converts them back into DC signals with respects to the cathode voltage and focus reference voltage of the sub-focus potentiometer in order to provide a focus signal and an unblanking signal of the operating voltages of the CRT.

6.12 HV Regulator (High Voltage Generator)

The high voltage generator produces an acceleration voltage (-1950 V) applied to the CRT cathode and a post-acceleration voltage (approximately +19 kV) applied to the CRT anode to accelerate the electrons beam which have passed the X and Y deflection plates and mesh electrode. The high voltage of approximately 3900 Vp-p generated by the blocking oscillator is 10-times voltage-multiplication rectified by a Cockcroft circuit into a positive voltage of approximately 19 kV and it is half-wave rectified into a negative voltage of -1950 V.

This DC-DC converter feeds the negative voltage of -1950 V via a high resistance circuit (R1114, R1115) to the control circuit (Q1101 - 1103) to obtain a stabilized acceleration voltage. It also is fed through a capacitor-coupling circuit to the DC regeneration circuit in order to be used as the switching signal.

6.13 Power Supply Circuit

The power supply circuit steps up or down with its power transformer the AC line voltage into various voltages and rectifies them to DC supply voltages for the various circuits of the oscilloscope. The primary winding of the power transformer is of a split type, in order that the oscilloscope can be operated on various AC line voltages by connecting the transformer taps in series or parallel as required by means of the line voltage selector plug (P-89). Regarding the secondary circuit, the transformer has one 6.3 V winding for the CRT heater and four windings of different voltages for different circuits of the CRT. The AC voltages of these four windings are rectifies and supplied as non-regulated +21 V power and regulated +150 V, +55 V, +12 V, +5 V, and -12 V powers.

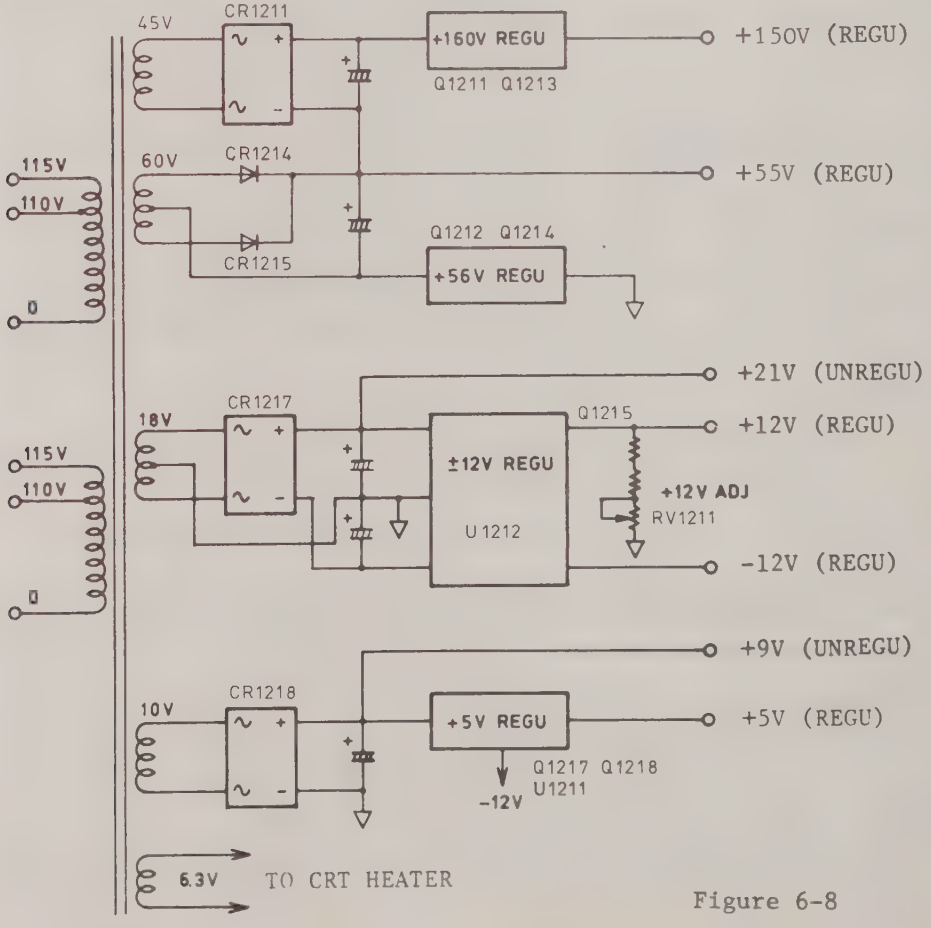


Figure 6-8

6.14 Calibrator Circuit

The calibrator circuit provides square-wave calibration voltage signals of 2 Vp-p and 200 mVp-p which are used for calibration of the probe and the amplifiers when they are operated in the non-calibrated mode. The voltage accuracy of the calibration signals is 2% or better. The calibration signals are produced by generating a signal with the multibrator of CMOS IC (U1101 1/4, 2/4), shaping the waveform with the Schmitt circuit of CMOS IC (U1101 3/4, 4/4), and dividing the voltage signal with resistors.

7. CALIBRATION

7.1 General

After the oscilloscope has been used for a period of time, it should be calibrated. Although calibration of overall performances is recommended, partial calibration may serve the purpose as that the time axis alone is calibrated when the time measuring accuracy is especially important or that the vertical axis alone is calibrated when the vertical sensitivity accuracy is of prime importance. After the oscilloscope has been repaired, overall calibration is suggested although it depends on the type of repair. For accurate calibration service, contact your Kikusui agent.

7.2 Removing the Case

To remove the case, remove the six screws (Figure 7-1) and pull out the chassis forward.

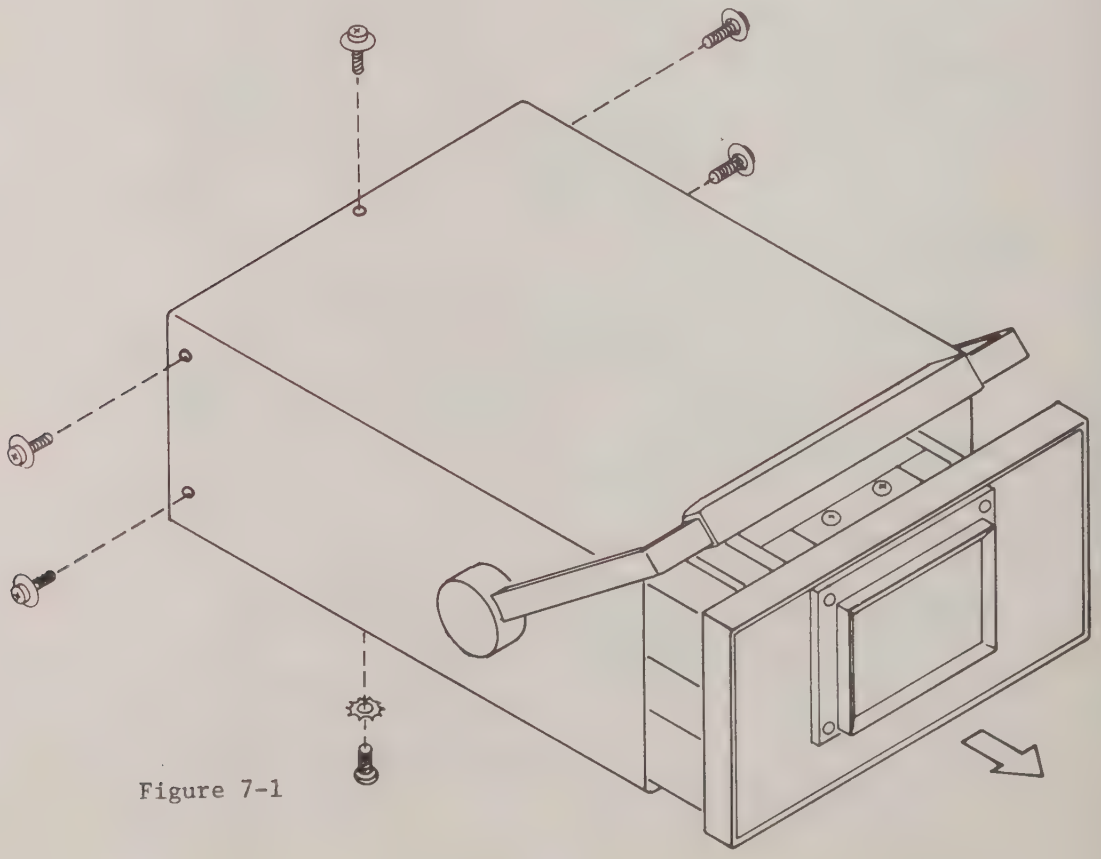


Figure 7-1

7.3 Check and Adjustment of DC Supply Voltages

Before calibrating the oscilloscope, its DC supply voltages should be checked and adjusted. Check and adjust the +12V supply voltage first and the other supply voltages next. The supply voltages shown in the following table and the check and adjustment points are indicated in Figures 7-2, 7-8 and 7-9.

Nominal voltage	Voltage range	Check and adjustment points
+ 5 V	+4.75 - 5.25 V	TP-2
+12 V	+11.95 - 12.05 V	TP-3 RV1211
-12 V	-11.80 - 12.20 V	TP-1
+55 V	+54 - 60 V	TP-4
+150 V	+150 - 160 V	TP-5
-1950 V	-1930 - -1970 V	TP-6 RV1101

For voltage check, measure the voltage between check point and ground using precision digital voltmeter. The +12V supply must be especially carefully adjusted because it provides a reference for other supplies. To mreasure the -1950V supply of which internal impedance is high, use a voltmeter which has a sufficiently high input impedance (10 MΩ or over).

Because adjustments of supply voltages largely affects vertical sensitivity and horizontal sweep time, the oscilloscope must be re-calibrated as explained in the subsequent paragraphs.

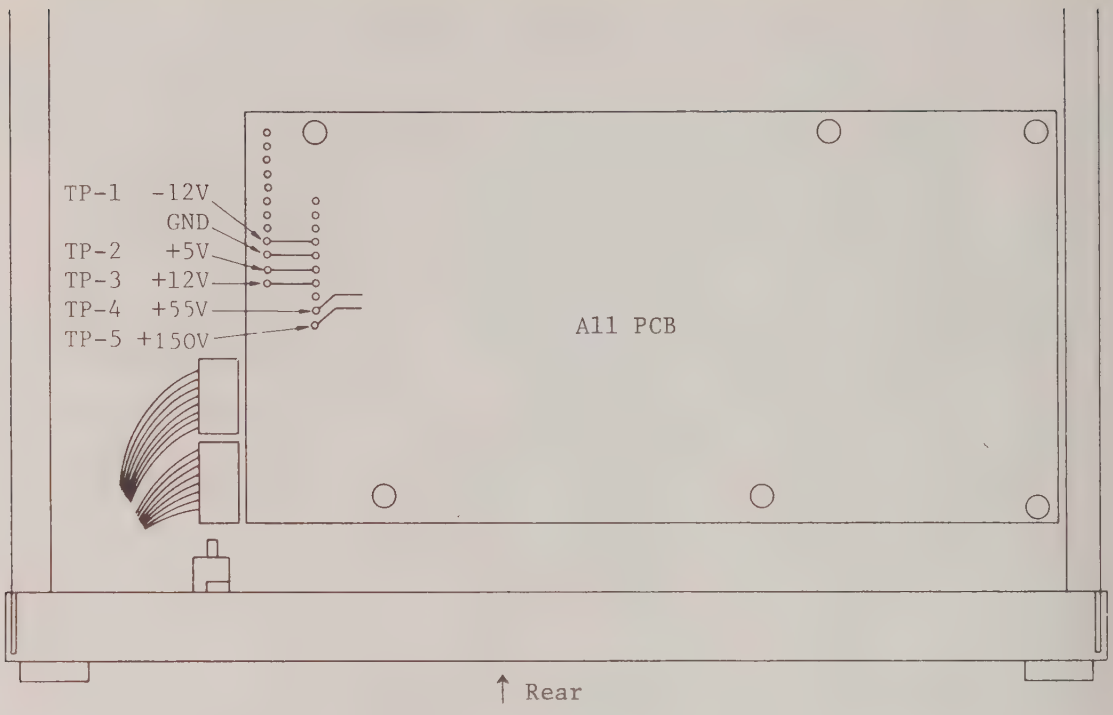


Figure 7-2 (Bottom view)

7.4 Adjustment of CRT Circuits

Some adjustments of the CRT circuits directly affect the CRT deflection sensitivity as is the case of "Check and Adjustment of DC Supply Voltages" of the preceding section. After the GEOMETRY, HALATION and HORIZ LIMIT are adjusted, the vertical sensitivity and sweep time must be calibrated.

- Adjustment of SUB INTEN:

  This control is for adjusting the trace intensity and the operating position of the INTEN knob (7).

(1) Set the TIME/DIV switch (39) at 1 mS and display a single-line horizontal trace on the screen.

(2) Set the white mark of the INTEN knob at the 10 o'clock position and so adjust the SUB INTEN control (Figure 7-9, RV1141) that the trace is displayed on the screen with a barely discernible intensity.

o Adjustment of GEOMETRY:

This control is for reducing geometrical distortions (pincushion distortions or barrel distortions) of the pattern displayed on the screen.

(1) Apply a sinusoidal signal of approximately 50 kHz to vertical input terminal and display the signal with an amplitude of 8 DIV and with approximately 50 peaks.

(2) So adjust the GEOMETRY control (Figure 7-9, RV1105) that the displayed pattern becomes as (b) in Figure 7-3.

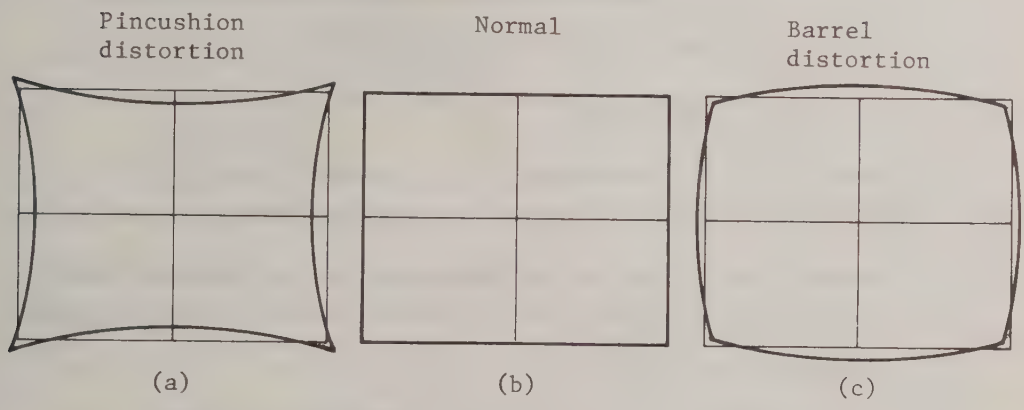


Figure 7-3

o Adjustment of HALATION:

This control is used to reduce halation on the screen to improve the contrast of the displayed waveform.
So adjust the HALATION control (Figure 7-9, RV1104) that the best forcus and contrast are obtained.

o Adjustment of SUB-FOCUS:

This control is for adjusting the control range position of the FOCUS knob (5). With the FOCUS knob set with its white dot positioned upright (noon position), so adjust the SUB-FOCUS control (Figure 7-9, RV1102) that the best focus is obtained.

o Adjustment of HORIZ LIMIT:

This control is used to suppress halation (caused by the electron beam reflected and scattered in the cathode-ray tube) resulting from change in the horizontal POSITION adjustment and × 10 MAG operation.

(1) Apply the CAL (43) signal to the vertical input terminals and display a waveforms with amplitude 4 DIV and 10 peaks.

(2) Pull out the × 10 MAG switch (41). Turn the HORIZ LIMIT control (Figure 7-8, RV1051) from the extremely counter-clockwise position gradually to clockwise position and stop at the position where halation on the screen is reduced. This is the normal position for the HORIZ LIMIT control.

o Adjustment of Y AXIS ALIGN:

This control is for adjustment of the perpendicularity (90°) between horizontal trace (sweep) and vertical trace.

(1) Ground CH1. Apply to CH2 the output of a sine wave signal generator and display the signal with an amplitude of 8 DIV on the screen.

(2) Set the VERT MODE switch (26) in the X-Y mode and so adjust the TRACE ROTATION control (4) that the vertical trace becomes parallel with the graticule scale.

(3) Next, change the VERT MODE switch to CH1 and so adjust the X-Y AXIS ALIGN (Figure 7-8, RV445) that the horizontal trace becomes parallel with the horizontal scale of the graticule.

By the above procedure, the horizontal trace and vertical trace are adjusted mutually perpendicular.

7.5 Adjustment of Vertical Axis

o Adjustment of STEP BAL:

This control is for minimizing the shift of trace when the VOLTS/DIV switch (16) or (23) is turned from the 5 mV position to the 20 mV position.

(1) Set the AC-GND-DC switch (13) or (20) and display the trace on the CRT screen.

(2) Turning the VOLTS/DIV switch between 5 mV and 20 mV positions, so adjust the STEP BAL control (Figure 7-11, RV101 or RV201) that the shift of trace becomes minimum.

o Adjustment of DC BAL:

This control is for minimizing the shift of the trace when the VARIABLE KNOB (15) or (22) is turned.

(1) Set the AC-GND-DC switch (13) or (20) in the GND stage and display the trace on the CRT screen.

(2) Turning the VARIABLE knob, so adjust the DC BAL control that the shift of the trace becomes minimum. (Figure 7-11, RV102 and RV202)

o Adjustment of × 5 MAG BAL:

This control is for minimizing the shift of trace when the × 5 MAG switch (15) or (22) is changed.

(1) Set the AC-GND-DC switch (13) or (20) in the GND state and display a trace on the screen.

(2) Turning on and off the × 5 MAG switch, so adjust the × 5 BAL (Figure 7-11, RV104 or RV204) that the shift of trace becomes minimum.

o Sensitivity calibration of CH1 and CH2:

Calibrate the sensitivity of the vertical amplifier to the value indicated by the VOLTS/DIV switch (16) or (23). For this adjustment, use a square wave generator with an output voltage setting accuracy of 0.3% or better, at 1 kHz.

(1) Set the signal generator output at 100 mVp-p and apply the signal to the vertical input terminal (14) or (21).

(2) Set the VARIABLE knob (15) or (22) at the CAL'D position and set the VOLTS/DIV switch at the 20 mV range.

(3) So adjust the CH1 or CH2 GAIN control (Figure 7-11, RV109 or RV209) that the amplitude of the displayed waveform becomes 5 DIV.

By the above procedure, other ranges also are calibrated to an accuracy of ±2% or better.

o Sensitivity calibration of CH3:

In a similar manner as for sensitivity calibration of CH1 and CH2, calibrate the sensitivity of the CH3 vertical amplifier.

(1) Set the signal generator output at 500 mVp-p and apply the signal to CH3 input terminal (12). Next, set the CH3 input ATT switch (9) to the 0.1 V state (⊓ state).

(2) So adjust the CH3 GAIN control (Figure 7-10, RV303) that the amplitude of the displayed waveform becomes 5 DIV.

o Sensitivity calibration of CH4 and CH5:

In a similar manner as for sensitivity calibration of CH1 and CH2, calibrate the sensitivities of CH4 and CH5 vertical amplifiers.

(1) Set the signal generator output at 400 mVp-p and apply the signal to CH4 input terminal (36) or CH5 input terminal (46).

(2) Change the source selector switch (35) or (48) to the EXT state and display a signal waveform on the screen. So adjust the CH4 or CH5 GAIN control (RV503 or RV661 in Figure 7-12 or Figure 7-10) that the signal is displayed with an amplitude of 4 DIV on the screen.

o Adjustment of VERT CENTER:

This adjustment is to make zero the shift of trace at the center of the screen when the CH2 INV switch is changed.

(1) Set the AC-GND-DC switch (13) (CH2) in the GND state and display the trace on the screen.

(2) Turning ON (⊓) and OFF (⊓) the CH2 INV switch (26) , so adjust the POSITION knob (17) that the shift of trace becomes zero. (CH 2)

(3) Under the above state, so adjusted the VERT CENTER control (Figure 7-11, RV446) that the trace is positioned at the center of the screen.

o Adjustment of ADD BAL:

With both CH1 and CH2 channels operating in a single-line horizontal trace mode at the center of the screen, so adjust this control that the traces do not shift even when the VERT MODE switch is changed to the ADD mode.

(1) Set the AC-GND-DC switches (13) and (20) in the GND state and display the traces of the two channels overlapped at the center of the screen.

(2) Change the VERT MODE switch to the ADD state and so adjust the ADD BAL control (Figure 7-11, RV401) that the traces are positioned at the center of the screen.

o Adjustment of square wave characteristics of vertical amplifiers:

This adjustment is to adjust the square wave characteristics of the vertical amplifiers and to make their frequency response flat. This adjustment should be done at a range which does not use the input attenuator (20 mV/DIV range), using two or more square waves of different frequencies.

Adjustment should be done using a quality square wave with a rise time of 1.0 nsec or faster, in the order of low, middle, and high ranges, repeating adjustment for a few times.

(1) Adjustment for low frequency range:

Set the VOLTS/DIV switch at 20 mV/DIV and the TIME/DIV switch at 20 μS/DIV. Apply to the vertical input terminal a square wave of 10 kHz and so adjust the signal generator output that the waveform is displayed with an amplitude of 6 DIV.

Next, so adjust RV444 (Figure 7-8) that the displayed waveform becomes as (b) in Figure 7-4.

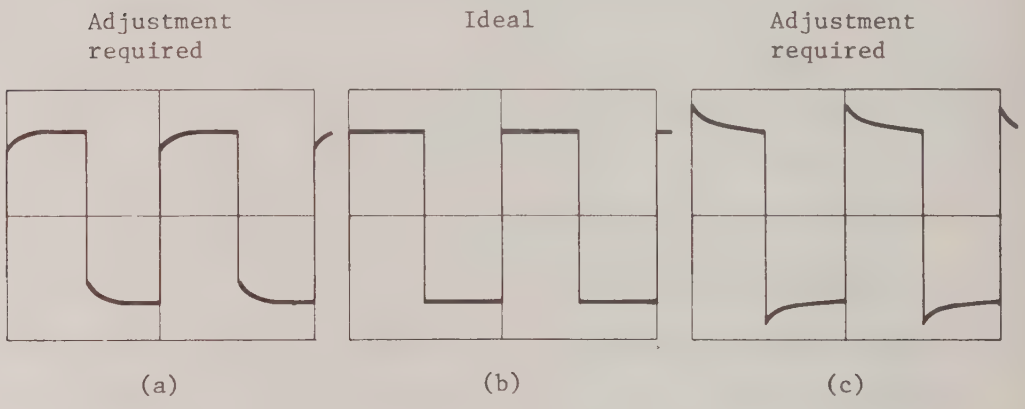


Figure 7-4

(2) Adjustment for middle frequency range:

Change the input pulse signal frequency to 1 MHz and set the TIME/DIV switch at 0.2 μS/DIV. Next, so adjust RV443 (Figure 7-8) that a square wave as shown in (b) of Figure 7-5 is displayed. Also, so adjust RV442 and C446 that the square wave characteristics at the front edge of the waveform becomes flat. For this adjustment, set at first R442 at an appropriate position and then adjust C446 so that a waveform as close to that of (d) as possible is obtained. Repeat this procedure for a few times so that a waveform as shown in (d) is obtained.

(3) Adjustment for high frequency range:

This adjustment is to make still more sharp the leading edge and reduce ringing at the leading edge of the pulse waveform which has been adjusted in step (2).

For this adjustment, adjust at first CH1 and CH2 to the same characteristics and adjust CH3, CH4 and CH5 next.

Change the TIME/DIV switch to the 20 mV/DIV position and expand the front edge of the pulse waveform which has been adjusted in step (2) "Adjustment for middle frequency range." First, adjust RV441 and C446 so that ringing becomes smaller and uniform. Next, adjust C445 so that ringing is eliminated.

Next, adjust RV402 and C410, and RV106 and C141 (RV206 and C241 in the case of CH2) so that the front edge of the displayed waveform becomes flat. Also adjust C407 and C142 (C242 in the case of CH2) so that the leading edge becomes sharp.

Repeat the above adjustment so that flat square wave characteristics with sharp leading edge is obtained and the difference between CH1 and CH2 becomes minimal.

Adjustment of the reference ranges of CH1 and CH2 is complete by the above procedure. Next, adjust the high ranges for 5 mV and 10 mV in the same procedure as for 20 mV.

	CH1	CH2
5 mV	C126	C226
10 mV	C162	C262

Next, change the channels to CH3, CH4 and CH5, and adjust the HF COMPEN controls of these channels.

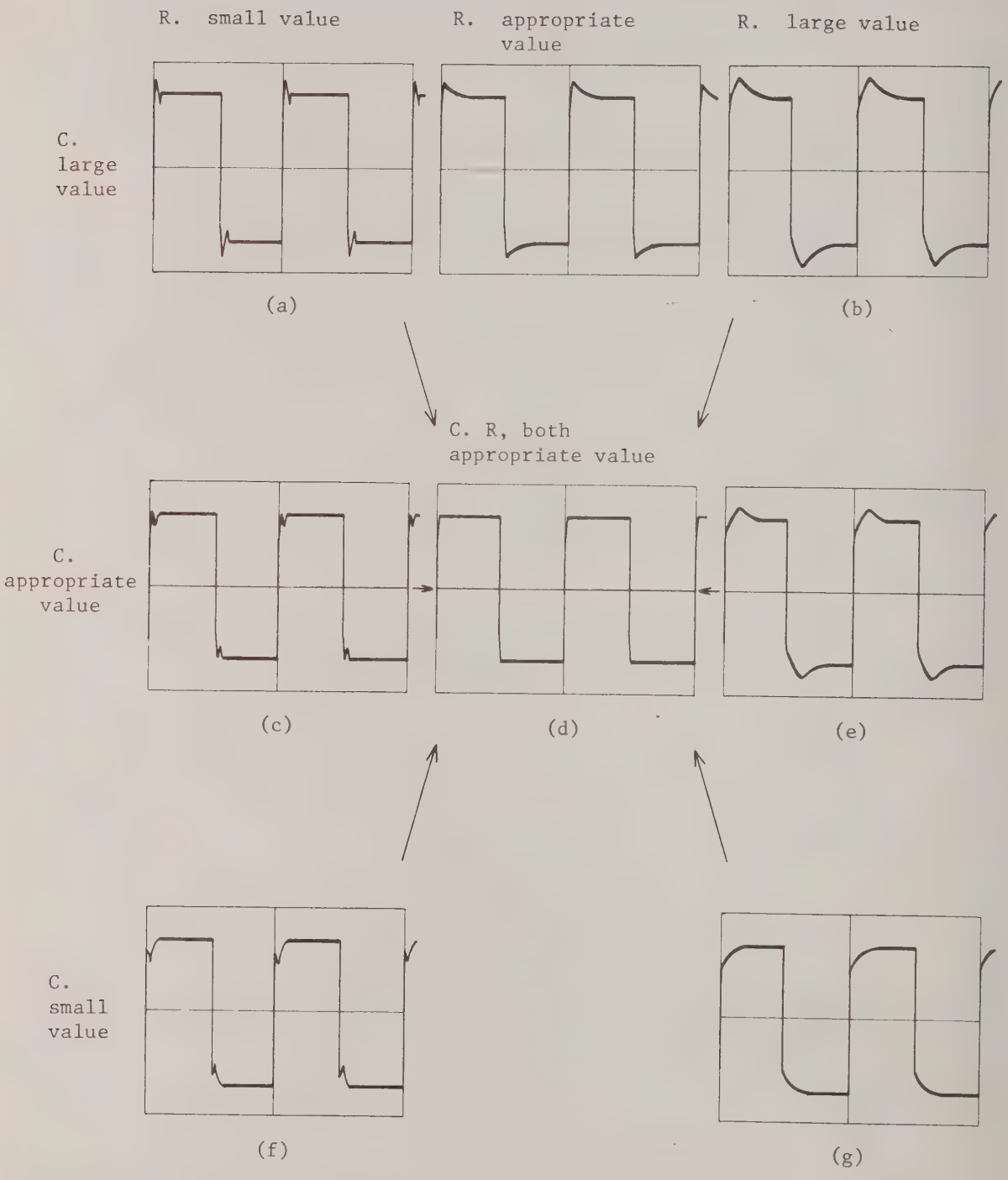

R. small value
R. appropriate value
R. large value
C. large value
(a)
(b)
C. R, both appropriate value
C. appropriate value
(c)
(d)
(e)
C. small value
(f)
(g)

Figure 7-5

	HF COMPEN
CH3	RV302 C316
CH4	C582
CH5	C662

After the above adjustment is done, check again that the frequency response characteristics of all channels are satisfactory.

o Adjustment of input ATT of CH1 and CH2:

The VOLTS/DIV switch selects the oscilloscope sensitivity by switching the attenuator circuit consisting of pre-stage attenuator (1/10-steps) and post-stage attenuator (1/1, 1/2.5, and 1/5-steps). This procedure is for phase compensation and input capacitance adjustment of the attenuators. Adjustments should be done in the order of phase compensation and input capacitance adjustment for the post-stage attenuator and then phase compensation and input capacitance adjustment of the pre-stage attenuator.

(1) Adjustment of post-stage attenuator:

Use a square wave signal generator which provides a quality square wave of rise time 1 μsec or faster, without sags or overshoots. Apply the signal for each of the ranges (50 mV, 0.1 mV) and display a waveform with an amplitude of 6 DIV. So adjust the phase compensation capacitors shown in the following table that an ideal waveform is displayed. Next, connect a low-capacitance C-meter to the input terminal and so adjust the input-capacitance compensation capacitor that the input capacitance at each range becomes 20 pF ±2 pF.

Compensation capacitor / Range	CH1		CH2	
	Phase compen-sation	Input capacitor	Phase compen-sation	Input capacitor
50 mV (1/2.5)	C112	C113	C212	C213
0.1 V (1/5)	C114	C115	C214	C215

(2) Adjustment of pre-stage attenuator:

In a similar manner as in the case of step (1), adjust at each of 0.2 V and 2 V ranges the phase compensation capacitors and input capacitance compensation capacitors as shown in the following table.

Compensation capacitor / Range	CH1		CH2	
	Phase compen-sation	Input capacitor	Phase compen-sation	Input capacitor
0.2 V (1/10)	C104	C105	C204	C205
2 V (1/100)	C107	C108	C207	C208

When the above adjustment is done, all other ranges also are automatically adjusted.

o Adjustment of input ATT of CH3:

In a similar manner as is the case for "Adjustment of input ATT of CH1 and CH2," adjust C305 so that the 1/1 input capacitance becomes 20 pF ±2 pF. Next, adjust input capacitance compensation capacitor C303 and phase compensation capacitor C302 of 1/5 ATT. (See Figure 7-10.)

Adjustment of input ATT of CH4 and CH5:

In a similar manner as above, adjust input capacitance compensation capacitors C502 (CH4) and C612 (CH5) and phase compensation capacitors C503 (CH4) and C611 (CH5) of 1/5 ATT. (See Figure 7-12 and 7-10.)

o Adjustment of DC offset CH1 signal output:

This adjustment is to make zero the DC offset of the CH1 signal output.

(1) Apply the CH1 signal output to the CH2 input terminal.

(2) Display the CH2 input signal on the screen and set the VOLTS/DIV switch at the 10 mV range.

(3) Changing the CH2 input coupling switch between GND and DC, so adjust the CH1 SIGNAL OUTPUT DC OFFSET control RV110 (Figure 7-11) that shift of the trace becomes zero.

7.6 Adjustment of Trigger Circuit

o Adjustment of CH1 TRIG DC OFFSET:

This adjustment is for offsetting to zero the DC-component displacement of the CH1 internal trigger output.

(1) Apply a sinusoidal signal of approximately 1 kHz to the CH1 input terminal and set the AC-GND-DC switch at AC.

(2) Set the VERT MODE switch at CH1, set the INT TRIG switch at CH1 or ALT, and display the signal with an amplitude of 8 DIV on the screen.

(3) Set the COUPLING switch at AC and so adjust the LEVEL knob that the trigger point is brought to the center of the displayed waveform amplitude.

(4) Change the COUPLING switch to DC and so adjust the CH1 TRIG DC OFFSET (Figure 7-11, RV107) that the trigger point is brought to the center of the displayed waveform amplitude.

o Adjustment of CH2 TRIG DC OFFSET:

This adjustment is for offsetting to zero the DC-component displacement of the CH2 internal trigger output.

For this adjustment, adjust CH2 TRIG DC OFFSET (Figure 7-11, RV207) in a similar manner as is the case for "Adjustment of CH1 TRIG DC OFFSET."

o Adjustment of CH3 TRIG DC OFFSET:

This adjustment is for offsetting to zero the DC-component displacement of the CH3 internal trigger output.

For this adjustment, adjust CH3 TRIG DC OFFSET (Figure 7-10, RV304) in a similar manner as is the case for "Adjustment of CH1 TRIG DC OFFSET."

7.7 Adjustment of Time Base

o Calibration of A sweep time:

This adjustment is for calibrating the sweep time to the values indicated by the TIME/DIV switch (39). For this adjustment, use time marker signals of accurate time intervals of 0.1 sec, 1 msec and 10 µsec or use signals of accurate frequencies of 10 Hz, 1 kHz and 100 kHz.

(1) Apply to the vertical input terminal a time marker signal of 0.1 sec or a signal of 10 Hz, and deflect the signal with an appropriate amplitude on the screen.

(2) Set the VARIABLE knob (41) in the CAL'D position. Set the TIME/DIV switch (39) at 0.1 sec.

(3) So adjust the 0.1S ADJ (Figure 7-9, RV802) that the displayed waveform conforms with scale divisions of the graticule.

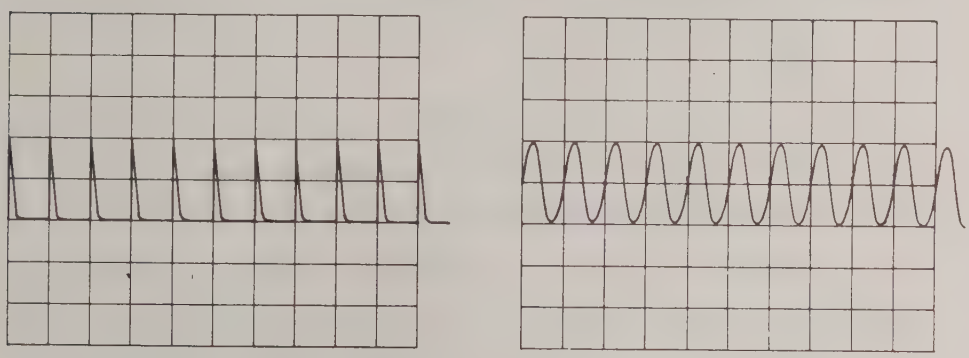
(4) Change the input signal to a time marker signal of 1 msec or sinusoidal wave signal of 1 kHz and change the TIME/DIV switch (39) to 1 msec.

(5) So adjust the 1mS CAL (Figure 7-9, RV801) that the displayed signal waveform conforms with scale divisions of the graticule.

(6) Next, change the input signal to a 10-µsec time marker signal or a 100-kHz repetitive frequency signal and change the TIME/DIV switch indication to 10µS.

(7) So adjust C814 (Figure 7-9) that the displayed signal waveform conform with scale divisions of the graticule.

When the above calibration is complete, the sweep speeds of the remaining ranges of the TIME/DIV switch (39) also are calibrated at an accuracy of ±3%.



Time marker signal　　Sinusoidal wave signal

Figure 7-6

o Calibration of B sweep time:

Calibrate the sweep time to the indicated values of the TIME/DIV switch (40). Adjust 0.1S and 1mS (Figure 7-9, RV902 and 901) and C904 (Figure 7-9) in a similar manner as that for the case of "Calibration of A sweep time."

o Adjustment of SWEEP LENGTH:

This adjustment is for setting the lengths of the A and B sweeps at 11 DIV. Set the TIME/DIV switches (39) and (40) at 1 mS and apply a time marker signal of 1 msec or a signal of repetition frequency 1 kHz, and so adjust the A SWEEP LENGTH (Figure 7-9, RV701) and B SWEEP LENGTH (Figure 7-9, RV702) that the sweep length become 11 DIV.

o Adjustment of sweep start point:

This adjustment is for attaining such state that, when the horizontal POSITION knobs (44) and (45) are set with their white dots in the noon positions, their sweeps start at the left hand end of the graticule.

(1) Set the TIME/DIV switches (39) and (40) at 1 mS, set the DISPLAY switch (29) at ALT, and display both A and B sweeps on the screen.

(2) So set the horizontal POSITION knobs (44) and (45) that their white dots are positioned upward (noon position). So adjust the A SWEEP START (Figure 7-9, RV1003) that the start point of the A sweep is brought to the left hand end of the graticule.

(3) Next, with the B SWEEP START (Figure 7-9, RV1004), bring the start point of the B trace to left hand end of the graticule.

o Adjustment of × 10 MAG:

This adjustment is for calibration of the sweep time when the × 10 MAG switch (41) is turned on (pulled out). Before performing this adjustment, make sure that the adjustment for "Calibration of the A sweep time" has been done.

(1) Apply to the vertical input terminal a time marker signal of 0.1 mS or a signal of 10 kHz and display the signal with an appropriate amplitude on the screen.

(2) Set the VARIABLE knob (41) in the CAL'D position and the TIME/DIV switch (39) at 1 mS.

(3) Turn on the × 10 MAG switch and so adjust the × 10 MAG GAIN ADJ (Figure 7-9, RV1005) that the displayed waveform conforms with scale divisions of the graticule.

o Calibration of DELAY TIME MULTI:

This calibration is for calibrating the dial value of the DELAY TIME MULTI to the sweep time. Before performing this calibration, make sure that the adjustment for "Calibration for A sweep time" has been done.

(1) Apply to the vertical input terminal a time marker signal of 1 mS and display the waveform with an appropriate amplitude on the screen.

(2) Set the VARIABLE knob (41) in the CAL'D position, set the TIME/DIV switch (39) at 1 mS, set the TIME/DIV switch (40) at 10 μS, and change the DISPLAY switch (29) to the A INTEN state.

(3) Set the dial indication of the DELAY TIME MULTI at 1.00 and align the displayed waveform with the graticule.

(4) So adjust the DT START (Figure 7-9, RV704) that the accentuated portion of the waveform is aligned to the initial pulse as shown in Figure 7-7.

(5) Set the dial indication of the DELAY TIME MULTI at 10.00.

(6) So adjust the DT END (Figure 7-9, RV703) that the accentuated portion of the waveform is aligned to the 10th pulse.

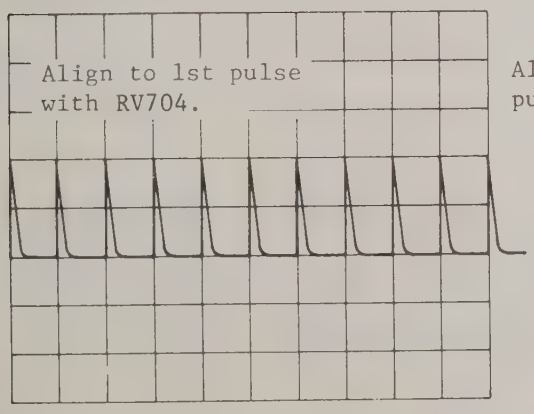


Figure 7-7

7.8 Adjustment of Horizontal Axis (X-axis)

o Calibration of horizontal sensitivity:

This adjustment is for calibration of the X-axis or CH3 HOR sensitivity for X-Y operation.

(1) Set at 100 mVp-p the output of the signal generator used for "Calibration of sensitivity" of section 7.5, and apply the output to the CH1 (X-axis) input terminal.

(2) Set the VERT MODE switch (26) in the X-Y state. Set the AC-GND-DC switch (13) of CH2 (Y-axis) at GND.

(3) Set the VARIABLE knob (22) at CAL'D and the VOLTS/DIV switch (23) at 10 mV.

(4) So adjust the CH1 & CH3 HOR GAIN (Figure 7-11, RV307) that the trace length becomes 10 DIV.

When this adjustment is done, the CH3 HOR sensitivity also is calibrated at the same time.

o Adjustment of CH1 & CH3 HOR POSITION:

This adjustment is to minimize the difference of trace positions between vertical-axis operation and horizontal-axis operation as controlled with the CH1 & CH3 POSITION controls (24) and (8).

(1) Set the VERT MODE switch (26) at CH1 and the AC-GND-DC switches (13) and (20) at GND.

(2) Move the trace to the center of the screen with the POSITION control knob (24).

(3) Next, turn the VERT MODE switch (26) to the X-Y position, and so adjust the CH1 & CH3 HOR POSITION CENT control (Figure 7-11, RV306) that the spot is placed in the center from the right and left ends.

7.9 Adjustment of Calibration Voltage

o Adjustment of repetition frequency:

This adjustment is for calibrating the repetition frequency of the calibration signal at 1 kHz.

(1) Connect the CALIB output (43) to a frequency counter.

(2) So adjust the CAL 1 kHz ADJ (Figure 7-10, RV1181) that the frequency counter 1 kHz.

o Calibration of the output voltage:

This adjustment is for calibrating the output voltage of the calibration signal in a substitution method.

(1) Set at 200 mVp-p the signal of the generator used for "calibration of sensitivity" of Section 7.5. Apply this signal to the CH1 input terminal.

(2) Display the signal on the screen with an amplitude of 8 DIV by adjusting the VOLTS/DIV switch (23) and VARIABLE knob (22).

(3) Apply the 200 mV CALIB output to the CH1 input terminal. So adjust the CAL OUTPUT LEVEL (Figure 7-10, RV1182) that the signal is displayed with an amplitude of 8 DIV on the screen in the same manner as step (2) above.

This completes the CAL voltage adjustment procedure.

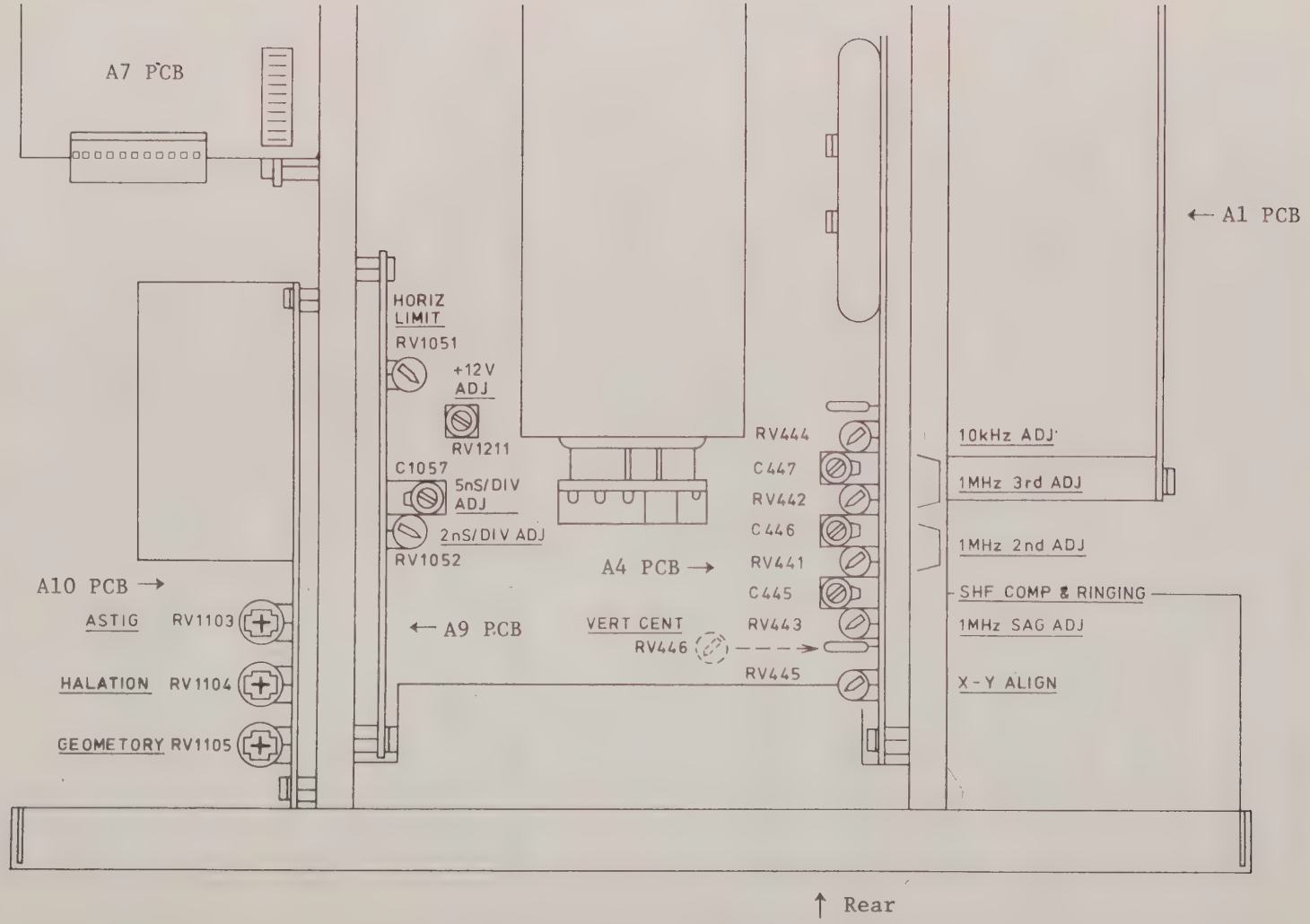


Figure 7-8 (Top view)

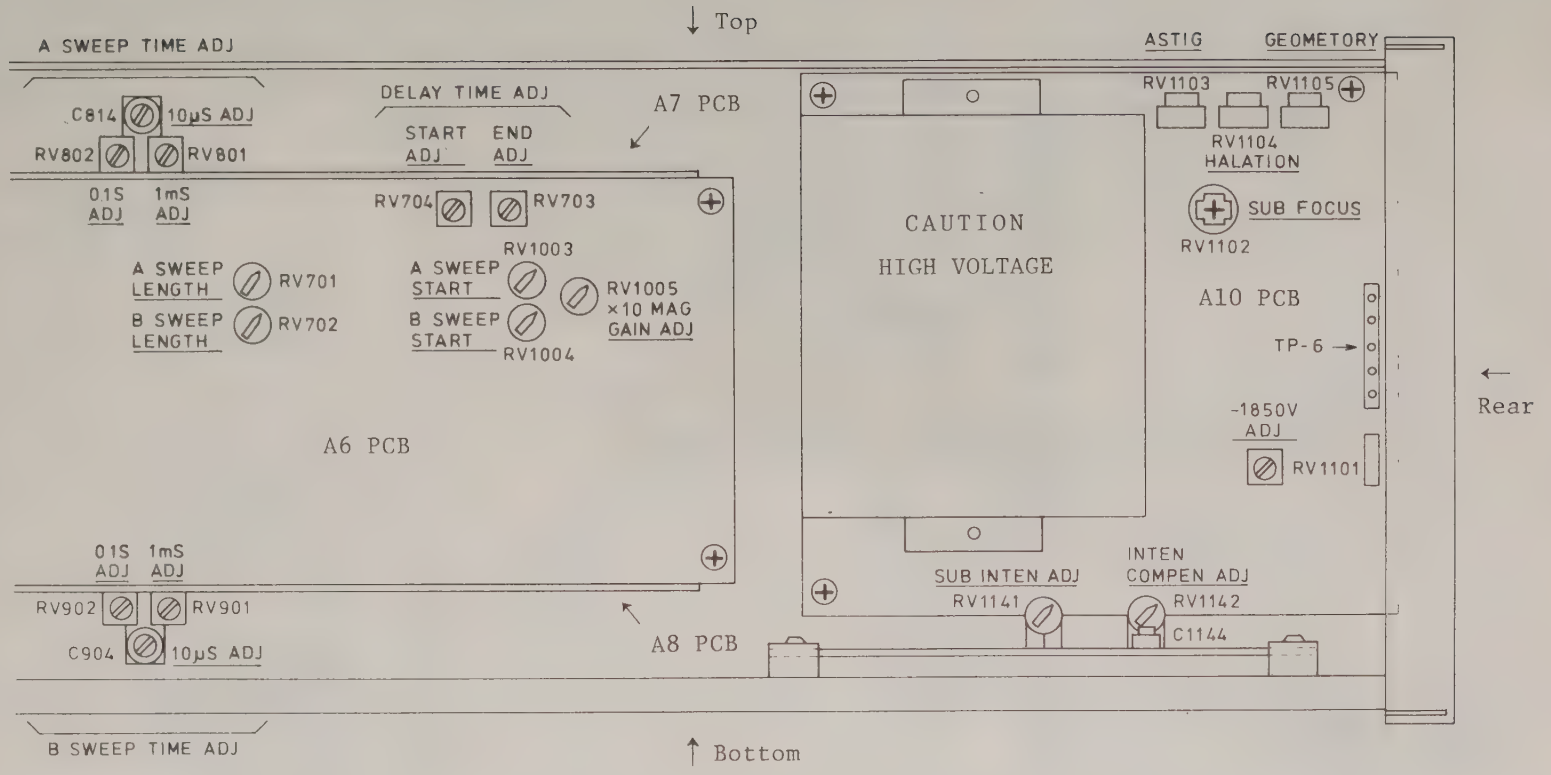


Figure 7-9 (Right hand side view)

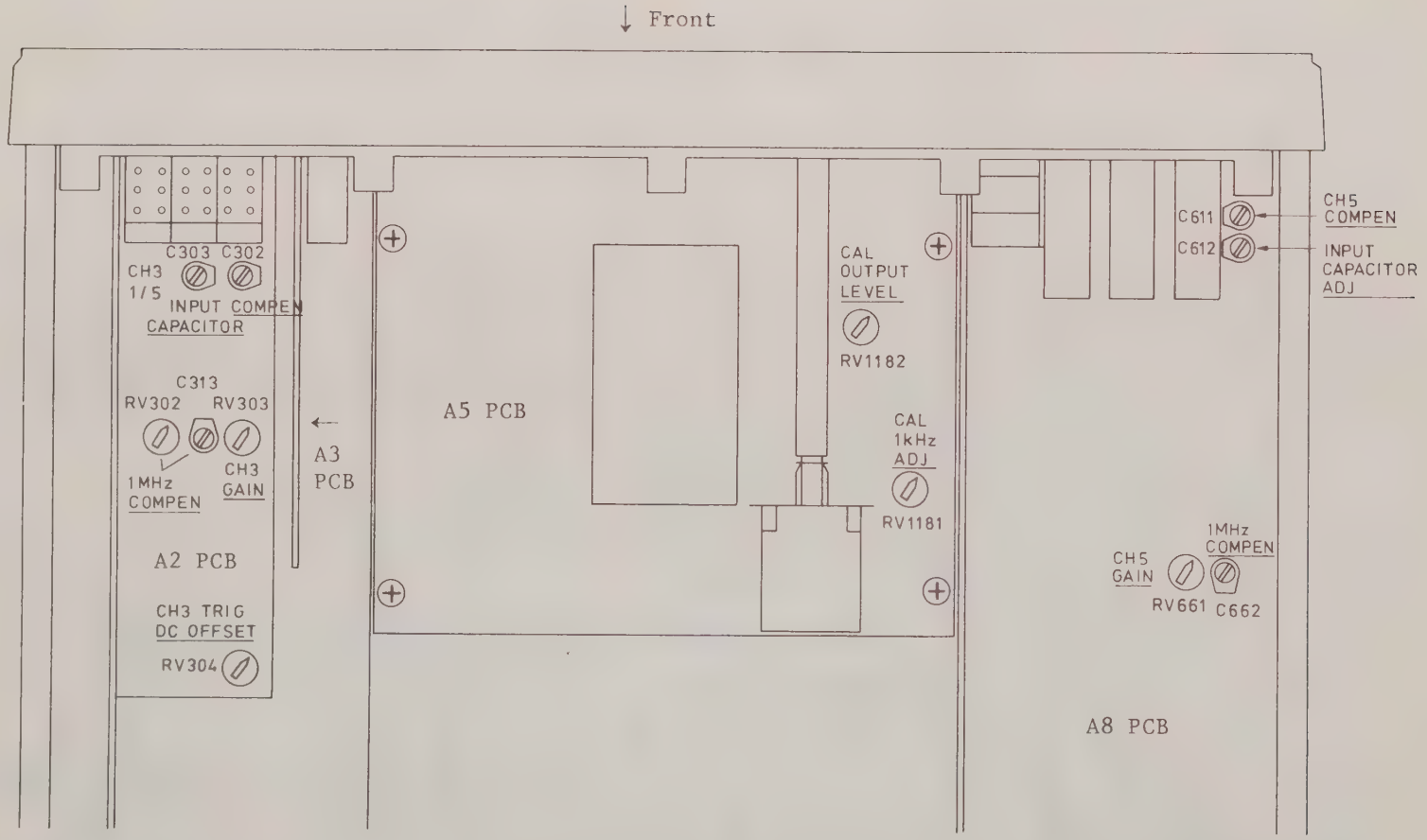


Figure 7-10 (Bottom view)

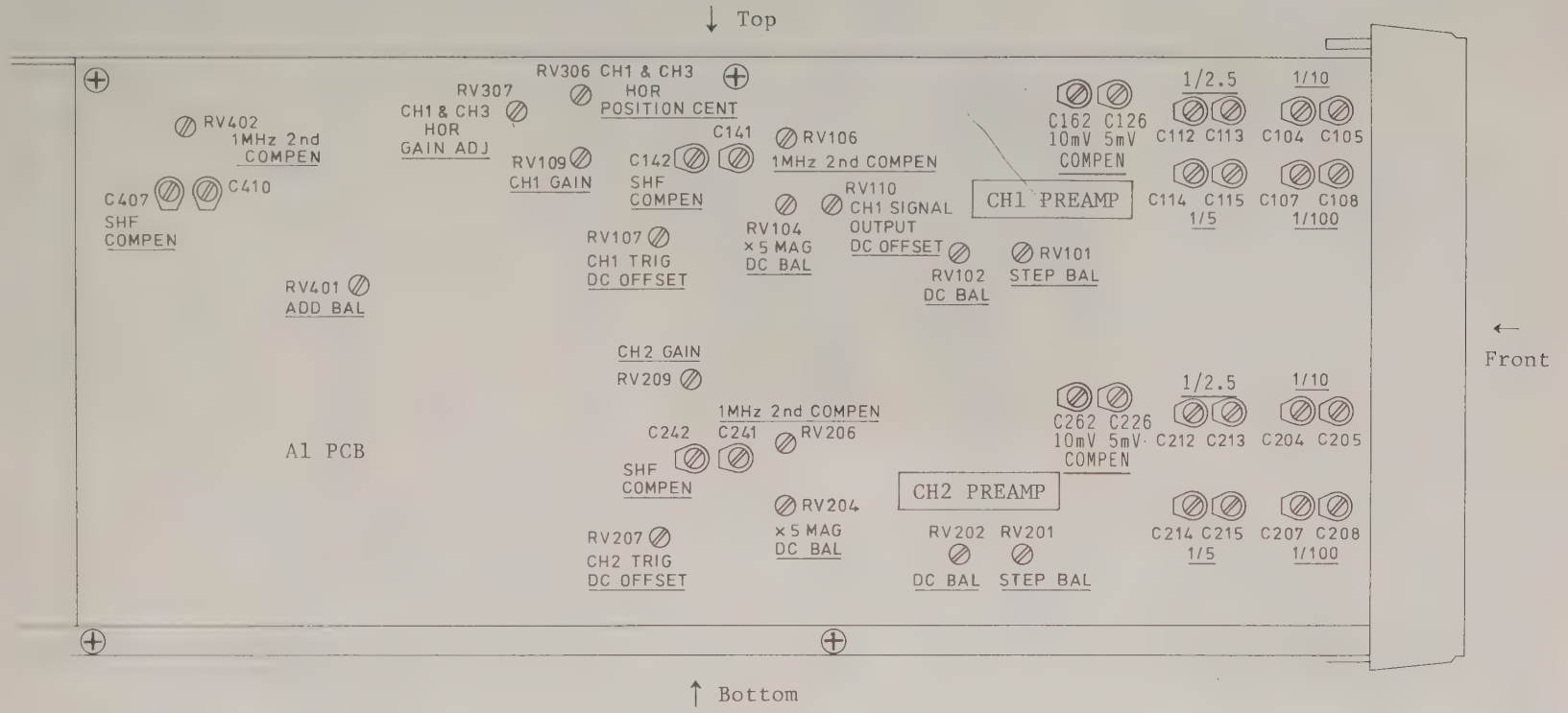


Figure 7-11 (Left hand side view)

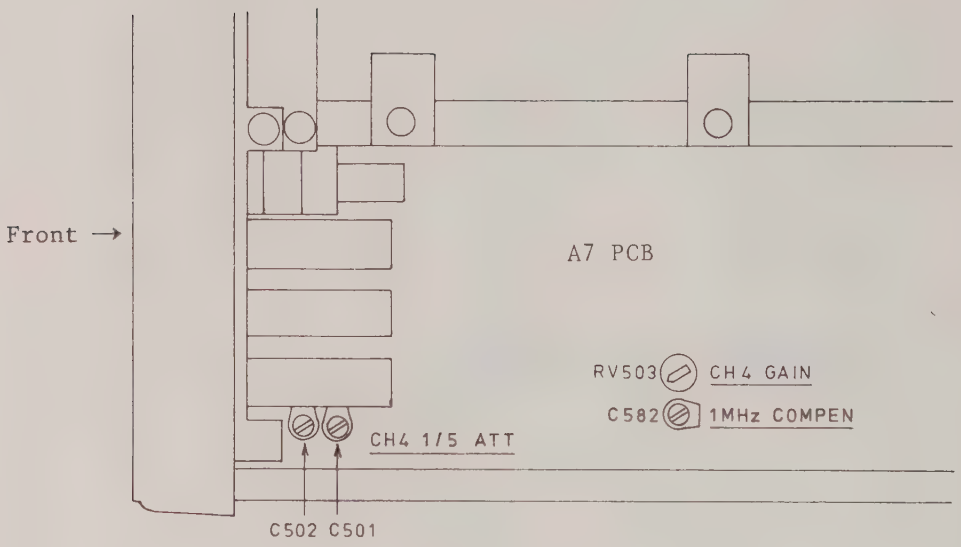


Figure 7-12 (Bottom view)

Table 8-1. Internal Inspection Checklist

ITEM	INSPECT FOR	REPAIR ACTION
Circuit boards	Loose, broken, or corroded solder connections. Burned circuit boards, burned, or cracked circuit run plating	Clean solder corrosion with an eraser and flush with isopropyl alcohol. Resolder connections. Determine cause of burned items, and repair. Repair damaged circuit runs.
Chassis	Dents, deformation, and damaged hardware.	Straighten, repair, or replace damaged hardware.
Resistors	Burned, cracked, broken, or blistered.	Replace damaged resistors.
Solder Connections	Cold solder or rosin joints.	Resolder and clean joint with isopropyl alcohol.
Wiring and Cables	Loose plugs or connectors. Burned, broken, or frayed.	Firmly seat connectors. Repair or replace damaged wire or cables.
Capacitors	Damaged or leaking cases. Corroded solder on terminals or leads.	Replace capacitors with damaged or leaking cases. Clean solder connections and flush with isopropyl alcohol.
Semiconductors	Loosely inserted in sockets. Bent pins.	Remove items with bent pins, carefully straighten the pins with long-nose pliers, and reinsert firmly (be sure that the straightening action hasn't cracked the pin such that it will break easily). Firmly seat all loose semiconductors.
Push-button controls	Binding controls. Missing push buttons.	Determine cause of binding control, and repair. Replace push buttons.

8.1 Troubleshooting

The following information is provided for troubleshooting the instrument. An understanding of the Operation Method in Section 4 may be helpful in location of troubles.

a. Troubleshooting Aids.

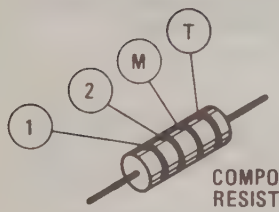
(1) Diagrams. Complete circuit diagrams are contained on foldout pages in Section 9, Diagrams. The portions of the circuit mounted on circuit boards are enclosed with heavy lines. The component numbers and electrical value of each component in this instrument are shown on the diagrams (see the Diagrams section for symbols used on diagrams). Each main circuit is assigned a series of component numbers to assist in identifying their circuit location.

(2) Circuit Board Illustrations. Each circuit diagram has an associated circuit board illustration located preceeding the circuit diagram.

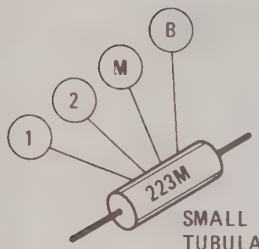
(3) Component Value Identification. Values of capacitors, diodes and resistors used in this instrument are identified by direct numerical values or by a color code scheme. Figure 8-1 shows the color code and numerical value schemes used.

(4) Troubleshooting Chart. A troubleshooting chart, Figure 8-2, is provided to aid in locating problem areas.

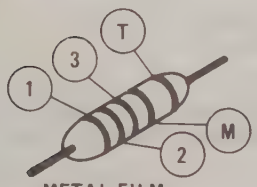
(5) Semiconductor Lead Configurations. Typical semiconductor lead configurations are shown in Figure 8-3.



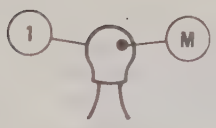
COMPOSITION RESISTORS



SMALL TUBULAR CAPACITORS



METAL-FILM RESISTORS



THERMISTORS

(1) (2) and (3) 1ST, 2ND, AND 3RD SIGNIFICANT FIGS. (B) TOLERANCE; F=±1%, J=5%, K=10%, M=20%

(M) MULTIPLIER (T) TOLERANCE (T) AND/OR (TC) COLOR CODE MAY NOT BE PRESENT ON SOME CAPACITORS

COLOR	SIGNIFICANT FIGURES	RESISTORS (Ω)		CAPACITORS (pF)		
		MULTIPLIER	TOLERANCE	MULTIPLIER	TOLERANCE	
					over 10 pF	under 10 pF
BLACK	0	1	– – –	1	±20%	±2 pF
BROWN	1	10	±1%	10	±1%	±0.1 pF
RED	2	10^2 or 100	±2%	10^2 or 100	±2%	– – –
ORANGE	3	10^3 or 1 K	±3%	10^3 or 1000	±3%	– – –
YELLOW	4	10^4 or 10 K	±4%	10^4 or 10,000	+100% –9%	– – –
GREEN	5	10^5 or 100 K	±½%	10^5 or 100,000	±5%	±0.5 pF
BLUE	6	10^6 or 1 M	±¼%	10^6 or 1,000,000	– – –	– – –
VIOLET	7	– – –	±1/10%	– – –	– – –	– – –
GRAY	8	– – –	– – –	10^{-2} or 0.01	+80% –20%	±0.25 pF
WHITE	9	– – –	– – –	10^{-1} or 0.1	±10%	±1 pF
GOLD	–	10^{-1} or 0.1	±5%	– – –	– – –	– – –
SILVER	–	10^{-2} or 0.01	±10%	– – –	– – –	– – –
NONE	–	– – –	±20%	– – –	±10%	±1 pF

Figure 8-1. COMPONENT VALUE IDENTIFICATION

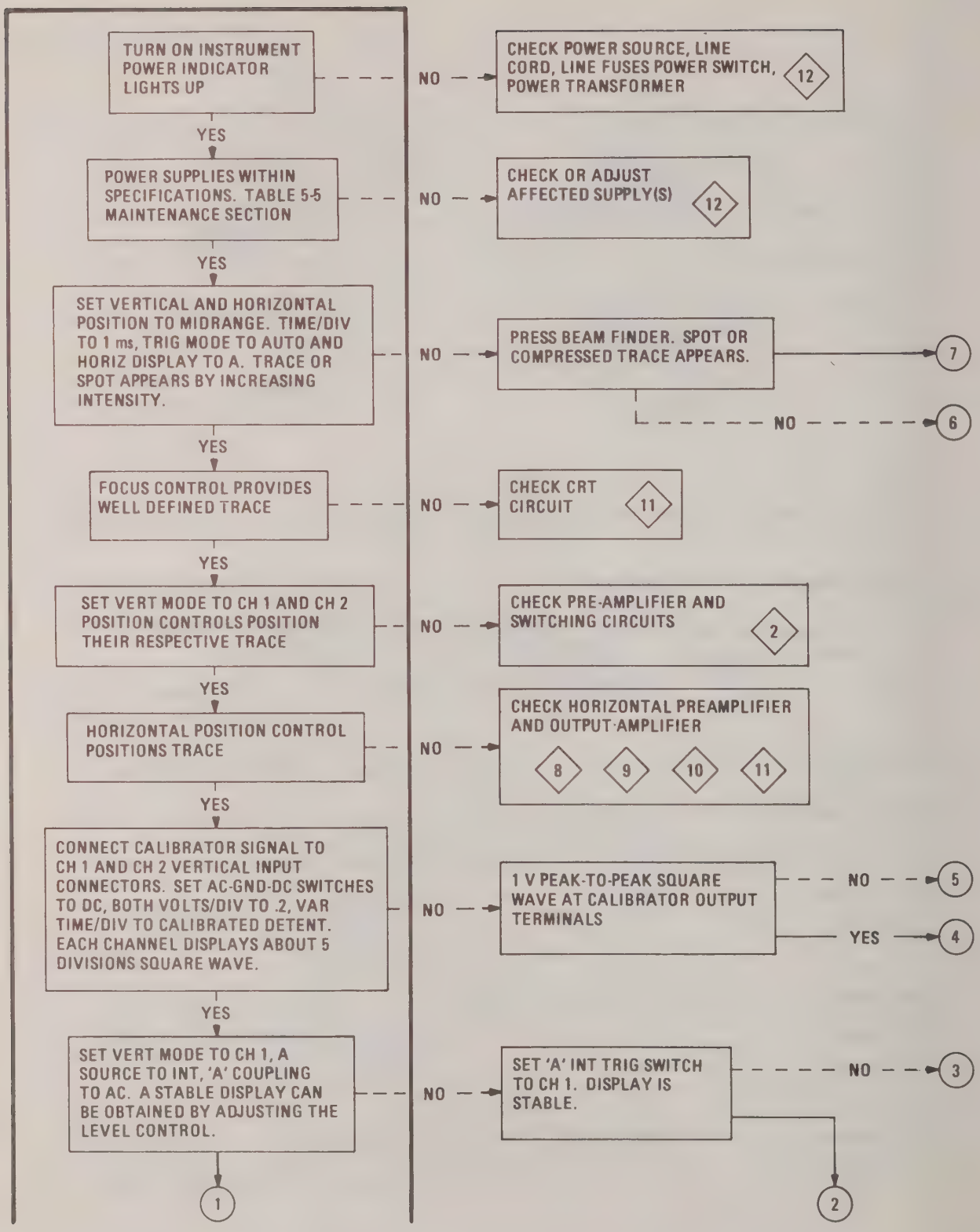

TURN ON INSTRUMENT POWER INDICATOR LIGHTS UP
NO
CHECK POWER SOURCE, LINE CORD, LINE FUSES POWER SWITCH, POWER TRANSFORMER
12
YES
POWER SUPPLIES WITHIN SPECIFICATIONS. TABLE 5-5 MAINTENANCE SECTION
NO
CHECK OR ADJUST AFFECTED SUPPLY(S)
12
YES
SET VERTICAL AND HORIZONTAL POSITION TO MIDRANGE. TIME/DIV TO 1 ms, TRIG MODE TO AUTO AND HORIZ DISPLAY TO A. TRACE OR SPOT APPEARS BY INCREASING INTENSITY.
NO
PRESS BEAM FINDER. SPOT OR COMPRESSED TRACE APPEARS.
7
NO
6
YES
FOCUS CONTROL PROVIDES WELL DEFINED TRACE
NO
CHECK CRT CIRCUIT
11
YES
SET VERT MODE TO CH 1 AND CH 2 POSITION CONTROLS POSITION THEIR RESPECTIVE TRACE
NO
CHECK PRE-AMPLIFIER AND SWITCHING CIRCUITS
2
YES
HORIZONTAL POSITION CONTROL POSITIONS TRACE
NO
CHECK HORIZONTAL PREAMPLIFIER AND OUTPUT AMPLIFIER
8
9
10
11
YES
CONNECT CALIBRATOR SIGNAL TO CH 1 AND CH 2 VERTICAL INPUT CONNECTORS. SET AC-GND-DC SWITCHES TO DC, BOTH VOLTS/DIV TO .2, VAR TIME/DIV TO CALIBRATED DETENT. EACH CHANNEL DISPLAYS ABOUT 5 DIVISIONS SQUARE WAVE.
NO
1 V PEAK-TO-PEAK SQUARE WAVE AT CALIBRATOR OUTPUT TERMINALS
NO
5
YES
4
YES
SET VERT MODE TO CH 1, A SOURCE TO INT, 'A' COUPLING TO AC. A STABLE DISPLAY CAN BE OBTAINED BY ADJUSTING THE LEVEL CONTROL.
NO
SET 'A' INT TRIG SWITCH TO CH 1. DISPLAY IS STABLE.
NO
3
1
2

Figure 8-2. TROUBLESHOOTING CHART (SHEET 1 OF 4)

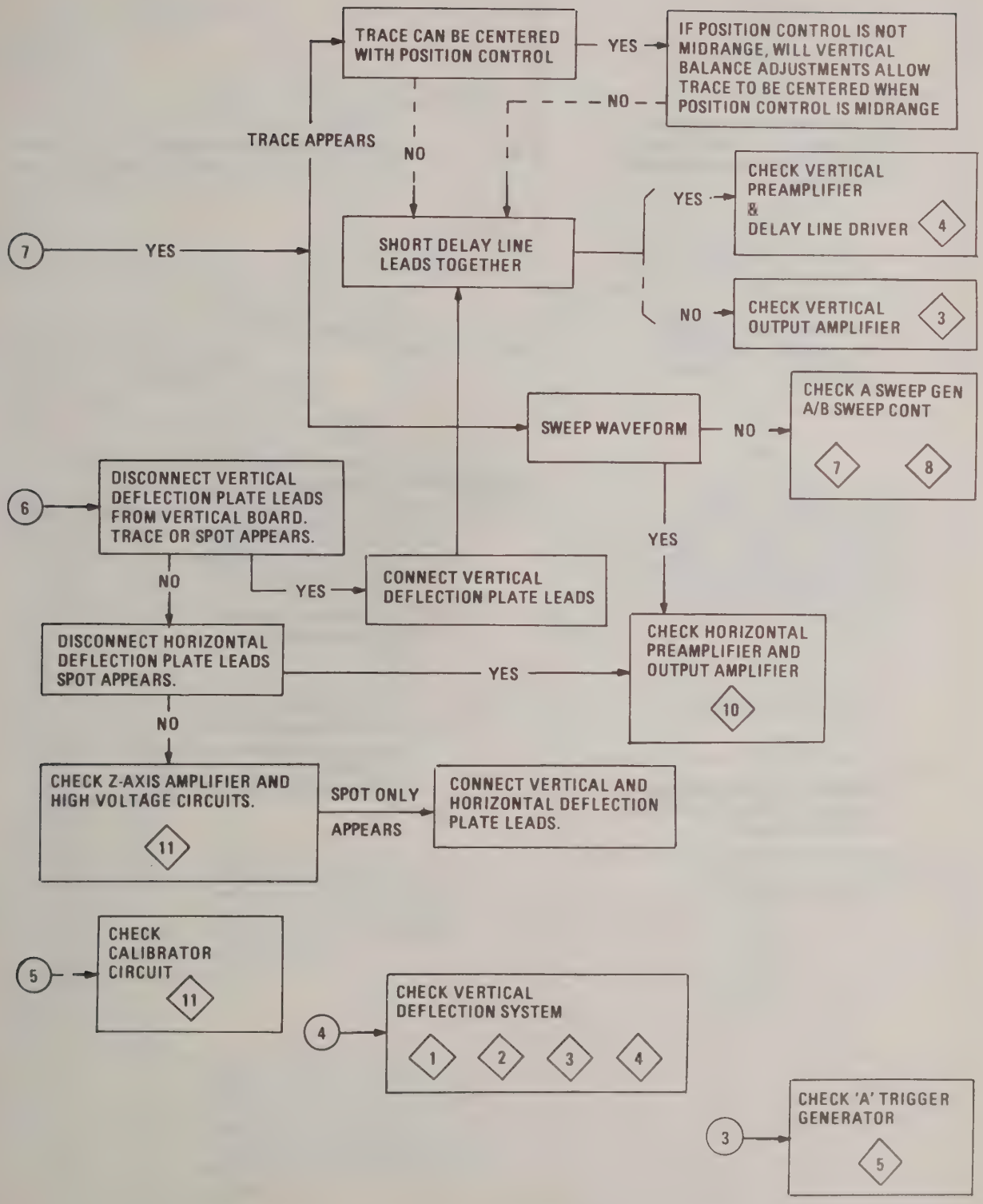


Figure 8-2. TROUBLESHOOTING CHART (SHEET 2 OF 4)

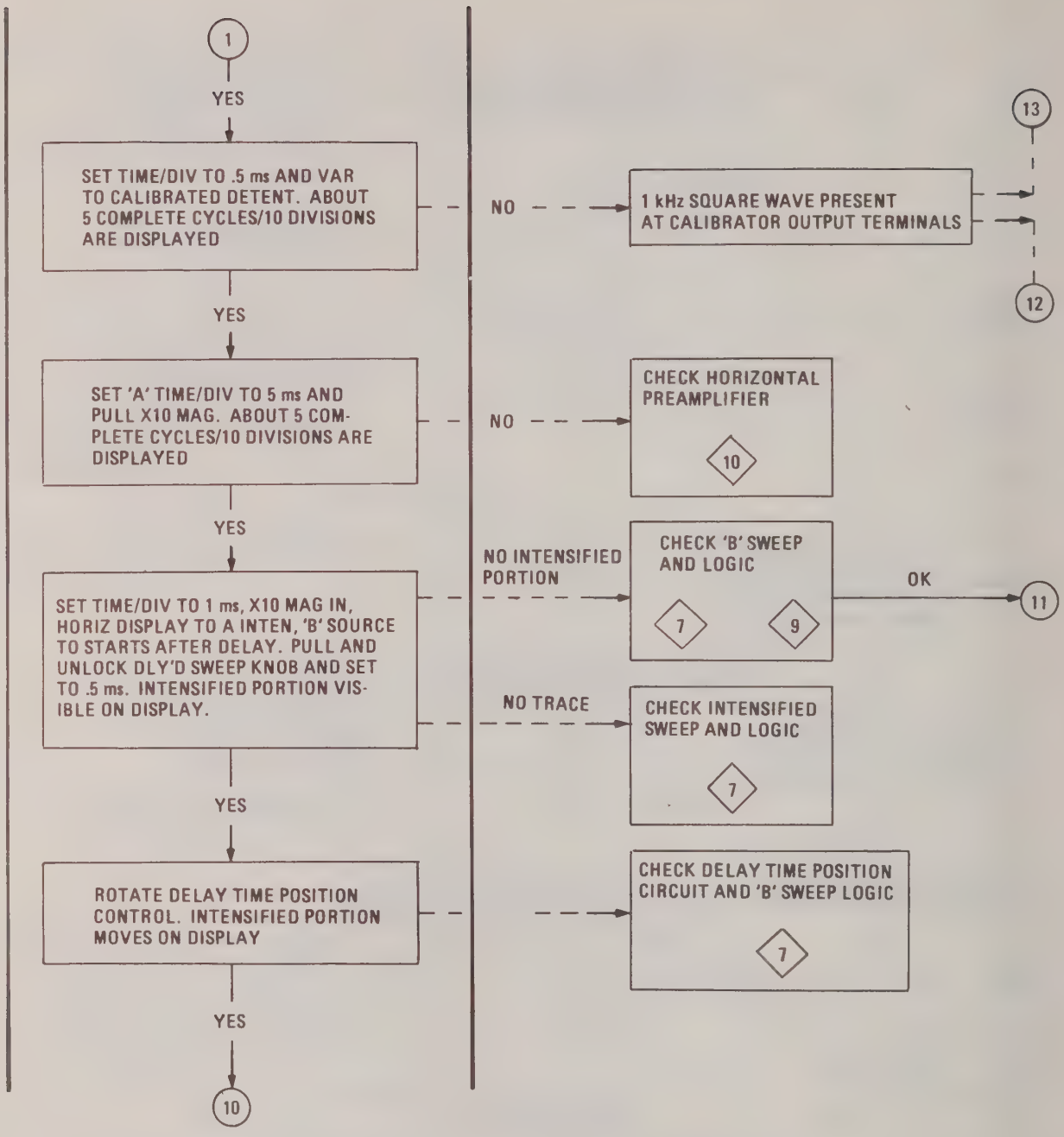

1
YES
SET TIME/DIV TO .5 ms AND VAR TO CALIBRATED DETENT. ABOUT 5 COMPLETE CYCLES/10 DIVISIONS ARE DISPLAYED
NO
1 kHz SQUARE WAVE PRESENT AT CALIBRATOR OUTPUT TERMINALS
13
12
YES
SET 'A' TIME/DIV TO 5 ms AND PULL X10 MAG. ABOUT 5 COMPLETE CYCLES/10 DIVISIONS ARE DISPLAYED
NO
CHECK HORIZONTAL PREAMPLIFIER
10
YES
SET TIME/DIV TO 1 ms, X10 MAG IN, HORIZ DISPLAY TO A INTEN, 'B' SOURCE TO STARTS AFTER DELAY. PULL AND UNLOCK DLY'D SWEEP KNOB AND SET TO .5 ms. INTENSIFIED PORTION VISIBLE ON DISPLAY.
NO INTENSIFIED PORTION
CHECK 'B' SWEEP AND LOGIC
7
9
OK
11
NO TRACE
CHECK INTENSIFIED SWEEP AND LOGIC
7
YES
ROTATE DELAY TIME POSITION CONTROL. INTENSIFIED PORTION MOVES ON DISPLAY
CHECK DELAY TIME POSITION CIRCUIT AND 'B' SWEEP LOGIC
7
YES
10

Figure 8-2. TROUBLESHOOTING CHART (SHEET 3 OF 4)

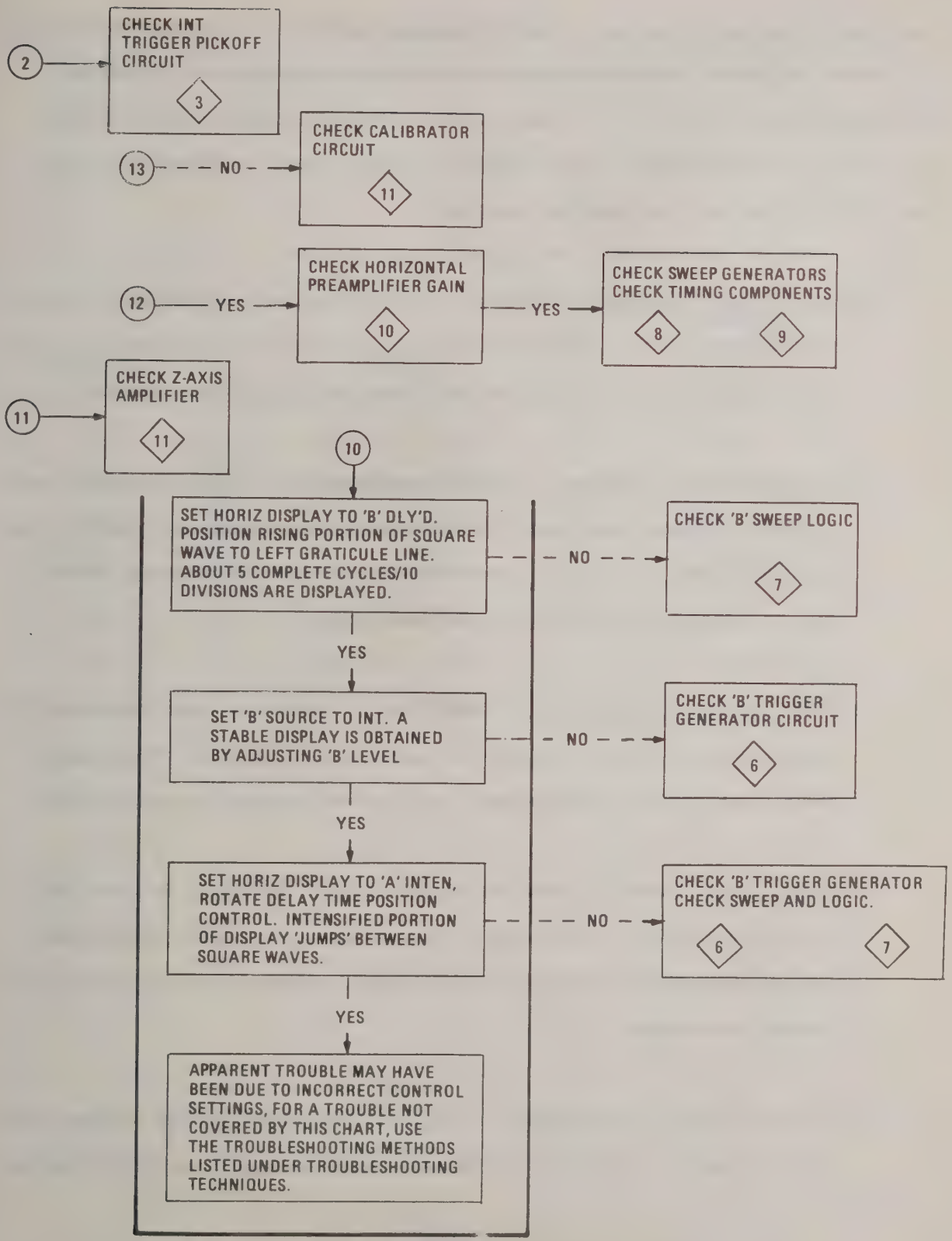

2
CHECK INT TRIGGER PICKOFF CIRCUIT
3
13
NO
CHECK CALIBRATOR CIRCUIT
11
12
YES
CHECK HORIZONTAL PREAMPLIFIER GAIN
10
YES
CHECK SWEEP GENERATORS CHECK TIMING COMPONENTS
8
9
11
CHECK Z-AXIS AMPLIFIER
11
10
SET HORIZ DISPLAY TO 'B' DLY'D. POSITION RISING PORTION OF SQUARE WAVE TO LEFT GRATICULE LINE. ABOUT 5 COMPLETE CYCLES/10 DIVISIONS ARE DISPLAYED.
NO
CHECK 'B' SWEEP LOGIC
7
YES
SET 'B' SOURCE TO INT. A STABLE DISPLAY IS OBTAINED BY ADJUSTING 'B' LEVEL
NO
CHECK 'B' TRIGGER GENERATOR CIRCUIT
6
YES
SET HORIZ DISPLAY TO 'A' INTEN, ROTATE DELAY TIME POSITION CONTROL. INTENSIFIED PORTION OF DISPLAY 'JUMPS' BETWEEN SQUARE WAVES.
NO
CHECK 'B' TRIGGER GENERATOR CHECK SWEEP AND LOGIC.
6
7
YES
APPARENT TROUBLE MAY HAVE BEEN DUE TO INCORRECT CONTROL SETTINGS, FOR A TROUBLE NOT COVERED BY THIS CHART, USE THE TROUBLESHOOTING METHODS LISTED UNDER TROUBLESHOOTING TECHNIQUES.

Figure 8-2. TROUBLESHOOTING CHART (SHEET 4 OF 4)

b. Troubleshooting Techniques. The following procedures are arranged in an order that checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection, operation, and calibration. If the trouble is not located by these checks, the remaining checks should aid in locating the defective component.

(1) Check Control Settings. Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the Operation Instructions section.

(2) Check Associated Equipment. Before proceeding with troubleshooting, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source.

(3) Check Instrument Calibration. Check the calibration of this instrument, or the affected circuit if the trouble exists in one circuit. The apparent trouble may only be misadjustment that can be corrected by calibration.

(4) Visual Check. Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged circuit boards, and damaged components.

(5) Isolate Trouble to a Circuit. Using the troubleshooting chart, Figure 8-2. isolate trouble to a particular circuit. The symptom often identifies the

defective circuit. Trouble appearing in more than one circuit can indicate possible power supply problems. Power supply tolerance and ripple limits can be checked using Table 8-2.

Table 8-2. Power Supply Voltages and Check Points

VOLTAGE	TOLERANCE	CHECK AND ADJUSTMENT POINT
+5V	+4.74 - 5.25V	TP-2
+12V	+11.95 - 12.05V	TP-3/RV1211
-12V	-11.8 - 12.1V	TP-1
+56V	+54 - 60V	TP-4
+155V	+150 - 160V	TP-5
-1950V	-1930 - -1970V	TP-6/RV1101

(6) Check Circuit Board Interconnections. After the trouble has been isolated to a particular circuit, check for loose or broken connections, improperly seated transistors and heat damaged components.

(7) Check Individual Components. The following procedures describe methods of checking individual components. Components which are soldered in place are best checked by disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

WARNING

The Power switch must be turned off before removing or replacing components to prevent electrical shock or circuit damage.

(a) Semiconductors. A good check of transistor operation is actual performance under operating conditions. A transistor can be most effectively checked by substituting a new component for it (or one which has been checked previously). However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static

type testers are not recommended, since they do not check operation under simulated operating conditions.

1 When troubleshooting transistors in the circuit with a voltmeter, measure the emitter to base and emitter to collector voltages to determine if the voltages are consistent with normal circuit voltages. Voltages across a transistor vary with the type of device and its circuit function. Some of these voltages are predictable. The emitter to base voltage of a conducting silicon transistor will normally be 0.6 to 0.8 volts. The emitter to collector voltages of a saturated transistor is about 0.2 volts. Because these values are small, the best way to check them is by connecting the voltmeter across the junction and using a sensitive voltmeter setting, rather than by comparing 2 voltages taken with respect to ground (both leads of the voltmeter must be isolated from ground if this method is used). If values less than these are obtained, either the device is short-circuited or no current is flowing in the circuit. If values are in excess of the base emitter values given, the junction is back biased or the device is defective. Values in excess of those given for emitter collector could indicate either a nonsaturated device operating normally, or a defective (open-circuited) transistor. If the device is conducting, voltage will be developed across resistances in series with it; if it is open, no voltage will be developed across resistances in series with it unless current is being supplied by a parallel path.

2 When troubleshooting field effect transistors, the voltages across its elements can be checked in the same manner as transistors. However, it should be remembered that normal depletion mode operation has the gate to source junction reverse biased, while the enhanced mode has the junction forward biased.

3 IC's (integrated circuits) can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of circuit operation is essential to troubleshooting circuits using IC's. Use care when checking voltages and waveforms around the IC's so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the 14- and 16-pin IC's is with an IC test clip. This device also doubles as an extraction tool.

(b) Diodes. A diode can be checked for an open or for a short circuit by measuring the resistance between terminals with an ohmmeter set to the R X 1 kilohm scale. The diode resistance should be very high in one direction and very low when the meter leads are reversed.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High currents can damage diodes. Check diodes in the same manner as transistor emitter to base junctions. Silicon diodes should have 0.6 to 0.8 volts across the junction when conducting. Higher readings indicate that they are either back biased or defective, depending on polarity.

(c) Resistors. Check the resistors with an ohmmeter. Check the parts list for tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies considerably from the specified value.

(d) Inductors. Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit.

(e) Capacitors. A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can be detected with a capacitance meter or by checking whether the capacitor passes ac signals.

2SK304

2SK107

2SK105

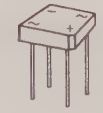
μPA63H1

FETS

1S1588
1SS83
1SS86
ERB26-20

GHV-06

V06G



2D4B41

TLR102KW
TLG102KW

TLG-105

DIODES

LEDS

2SC2055

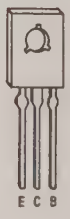
2SA844 2SC945
2SA1005 2SC1730
2SA1015 2SC1843
2SC1907
2SC2120

2SC1164

2SA1206

2SC2570

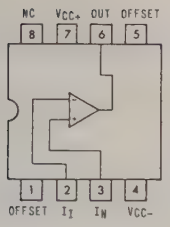
2SB834
2SC1505
2SD880-Y



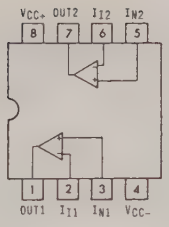
2SB648A
2SC2371L
2SD668A

TRANSISTORS

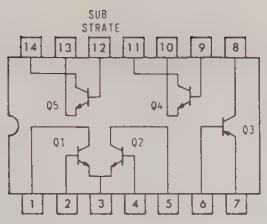
Figure 8-3. SEMICONDUCTOR LEAD CONFIGURATIONS (SHEET 1 of 3)



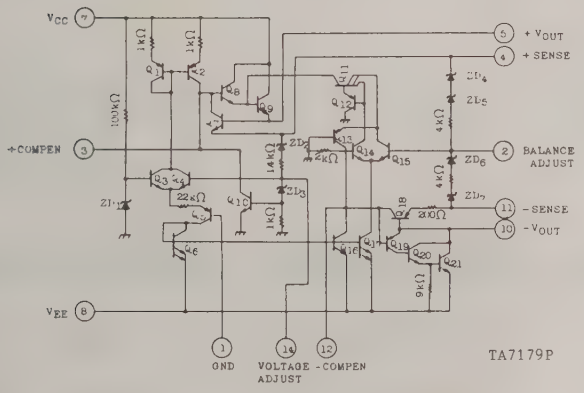
(TOP VIEW)
TL081CP



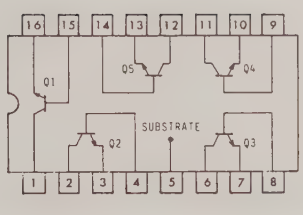
(TOP VIEW)
μPC4558C



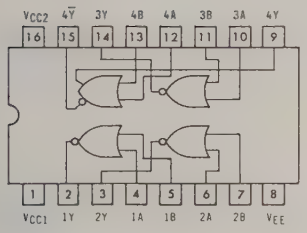
(TOP VIEW)
CA3086



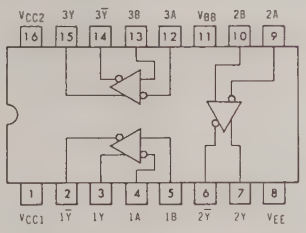
TA7179P



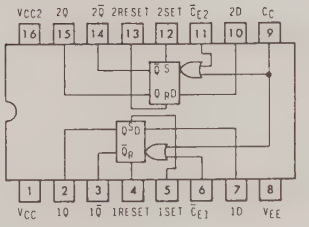
(TOP VIEW)
CA3127E



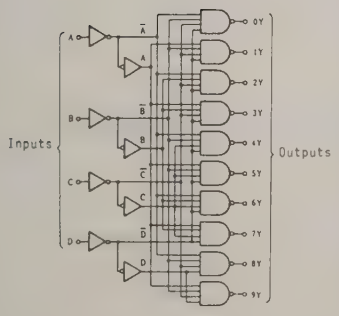
(TOP VIEW)
HD10102
MC10H102



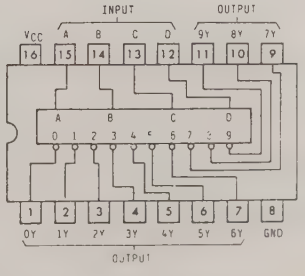
(TOP VIEW)
HD10116
MC10H116



(TOP VIEW)
MC10H131

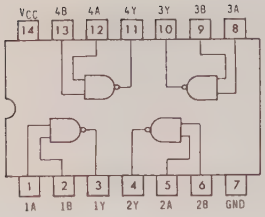


No.	BCD IN				Decimal OUT									
	D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	L	L	L	L	L	H	H	H	H	H	H	H	H	H
1	L	L	L	H	H	L	H	H	H	H	H	H	H	H
2	L	L	H	L	H	H	L	H	H	H	H	H	H	H
3	L	L	H	H	H	H	H	L	H	H	H	H	H	H
4	L	H	L	L	H	H	H	H	L	H	H	H	H	H
5	L	H	L	H	H	H	H	H	H	L	H	H	H	H
6	L	H	H	L	H	H	H	H	H	H	L	H	H	H
7	L	H	H	H	H	H	H	H	H	H	H	L	H	H
8	H	L	L	L	H	H	H	H	H	H	H	H	L	H
9	H	L	L	H	H	H	H	H	H	H	H	H	H	L
INVALID	H	L	H	L	H	H	H	H	H	H	H	H	H	H
	H	L	H	H	H	H	H	H	H	H	H	H	H	H
	H	H	L	L	H	H	H	H	H	H	H	H	H	H
	H	H	L	H	H	H	H	H	H	H	H	H	H	H
	H	H	H	L	H	H	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H	H	H	H	H	H	H

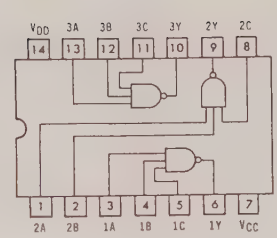


(TOP VIEW)
SN74LS42

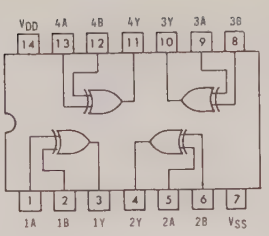
Figure 8-3. SEMICONDUCTOR LEAD CONFIGURATIONS (SHEET 2 OF 3)



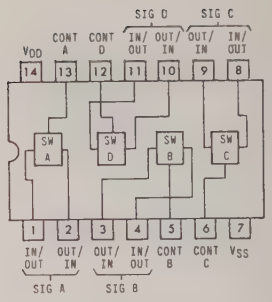
(TOP VIEW)
TC4011BP



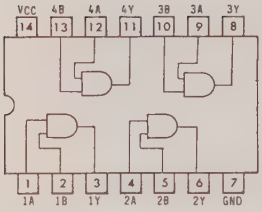
(TOP VIEW)
TC4023BP



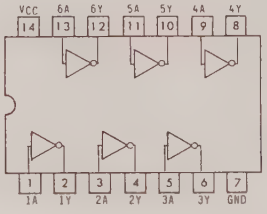
(TOP VIEW)
TC4030BP


SIG D
SIG C
VDD CONT A CONT D IN/OUT OUT/IN OUT/IN IN/OUT
14 13 12 11 10 9 8
SW A
SW D
SW B
SW C
1 2 3 4 5 6 7
IN/OUT OUT/IN OUT/IN IN/OUT CONT B CONT C VSS
SIG A
SIG B

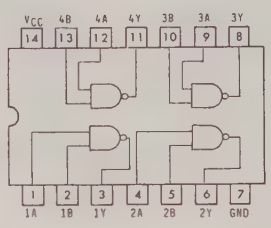
(TOP VIEW)
TC4066BP



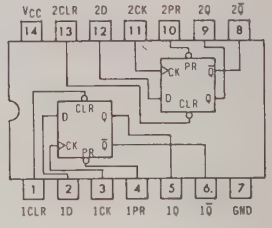
(TOP VIEW)
SN74LS00N
74F00PC



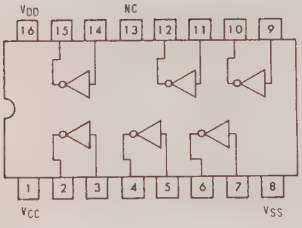
(TOP VIEW)
SN74LS04



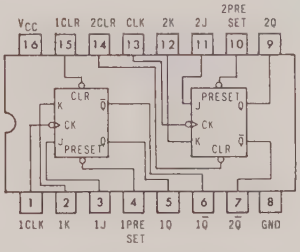
(TOP VIEW)
SN74LS08



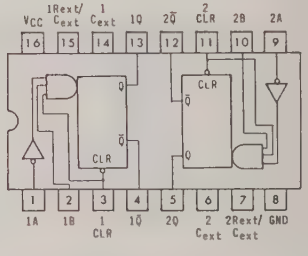
(TOP VIEW)
SN74LS74



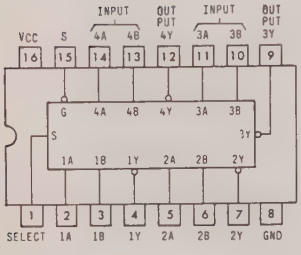
(TOP VIEW)
TC4009P



(TOP VIEW)
SN74S112N
SN74LS112N



(TOP VIEW)
LS74123


INPUT OUTPUT INPUT OUTPUT
VCC S 4A 4B 4Y 3A 3B 3Y
16 15 14 13 12 11 10 9
G 4A 4B 4Y 3A 3B
S 3Y
1A 1B 1Y 2A 2B 2Y
1 2 3 4 5 6 7 8
SELECT 1A 1B 1Y 2A 2B 2Y GND

(TOP VIEW)
74LS158

INPUT				OUTPUT
Strobe	Select	A	B	Y
H	×	×	×	H
L	L	L	×	H
L	L	H	×	L
L	H	×	L	H
L	H	×	H	L

Figure 8-3. SEMICONDUCTOR LEAD CONFIGURATIONS (SHEET 3 OF 3)

9. DIAGRAMS

9.1 Introduction.

This section contains diagrams and associated data for maintaining the instrument.

9.2 Arrangement.

a. Schematic Diagrams. Schematic diagrams are drawn to group circuit functions; therefore, any one diagram may include portions of any number of circuit boards or assemblies. To aid in tracing circuits from one diagram to another, each diagram is identified with a name and a number in a diamond shaped box. Circuits going from one diagram to another identify the destination component and destination diagram number.

b. Symbols and Reference Designators.

(1) Electrical components shown on the diagrams are in the following units unless noted otherwise.

Capacitors	Values are in farads.
Resistors	Ohms (Ω).

* Optimum value factory sected. Average value shown (parts may be omitted).

△ Metal film resistors.

(2) Table 9-1 is a partial listing of prefix letters used as reference designators. These are used to identify components or assemblies on the diagrams.

Table 9-1. Reference Designators

REFERENCE DESIGNATOR	DESCRIPTION	REFERENCE DESIGNATOR	DESCRIPTION
A	Assembly, separable or repairable (circuit board, etc.)	R	Resistor, fixed
		RV	Resistor, variable
C	Capacitor, fixed or variable	S	Switch
CR	Diode	T	Transformer
DL	Delay line	TP	Test point
F	Fuse	U	Integrated circuit, inseparable or nonrepairable (integrated circuit, etc.)
FL	Filter		
J	Connector, movable portion		
L	Inductor, fixed or variable	V	Electron tube
	Connector, stationary		
P	Connector, stationary portion		
Q	Transistor or silicone-controlled rectifier		
QCR	Transistor, Diode connection		

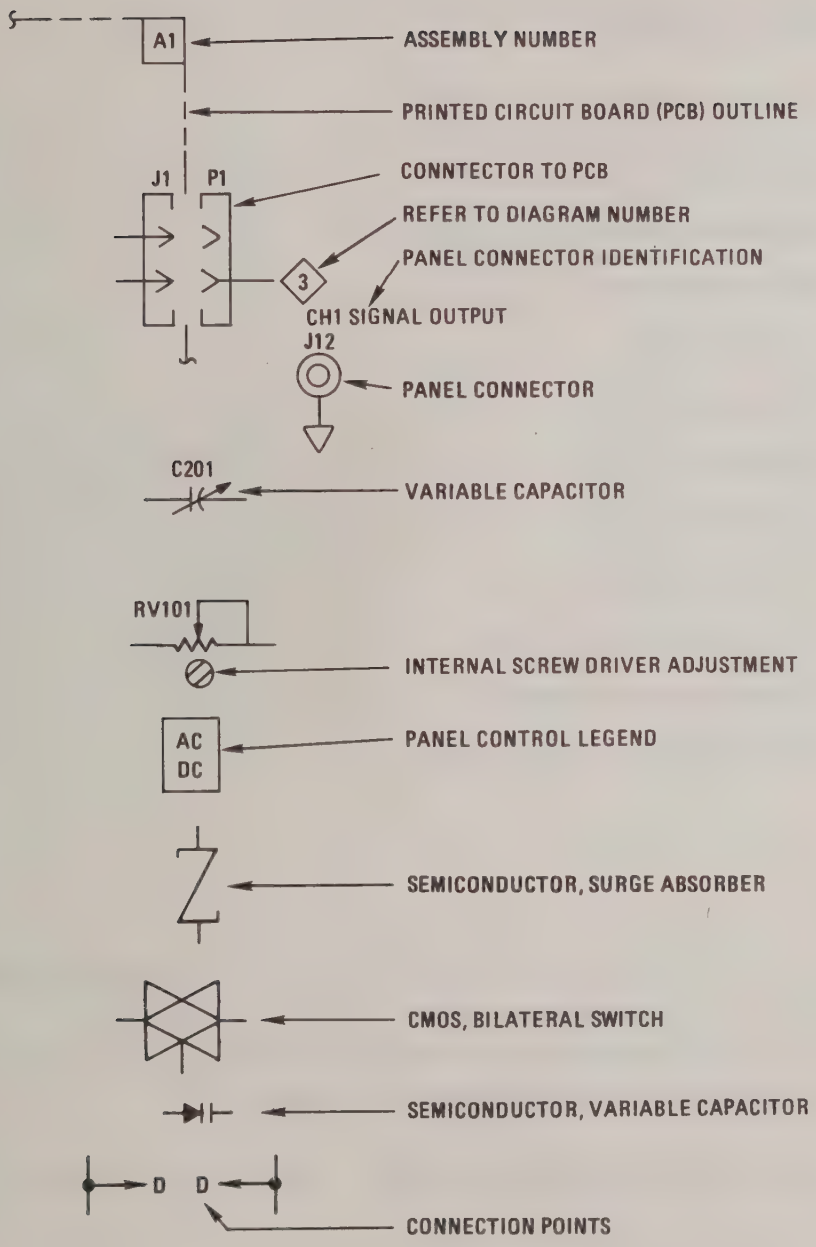


Figure 9-1. SCHEMATIC SYMBOLS

* BLOCK DIAGRAM 141

* SCHEMATIC DIAGRAMS 143

ATT AND PREAMP ..... ◇1◇ 143
VERT SWITCH ..... ◇2◇ 145
SWICHING CIRCUIT AND INT TRIG AMP .. ◇3◇ 147
VERT OUTPUT AMP ..... ◇4◇ 149
A TRIG CIRCUIT ..... ◇5◇ 151
B TRIG CIRCUIT ..... ◇6◇ 153
A/B SWEEP CONTROL ..... ◇7◇ 155
A SWEEP GENERATOR ..... ◇8◇ 157
B SWEEP GENERATOR ..... ◇9◇ 159
HOR SWITCH AND OUTPUT AMP ..... ◇10◇ 161
HV REGU AND CRT CIRCUIT ..... ◇11◇ 163
POWER SUPPLY AND CRT CONTROL ..... ◇12◇ 165

NOTES

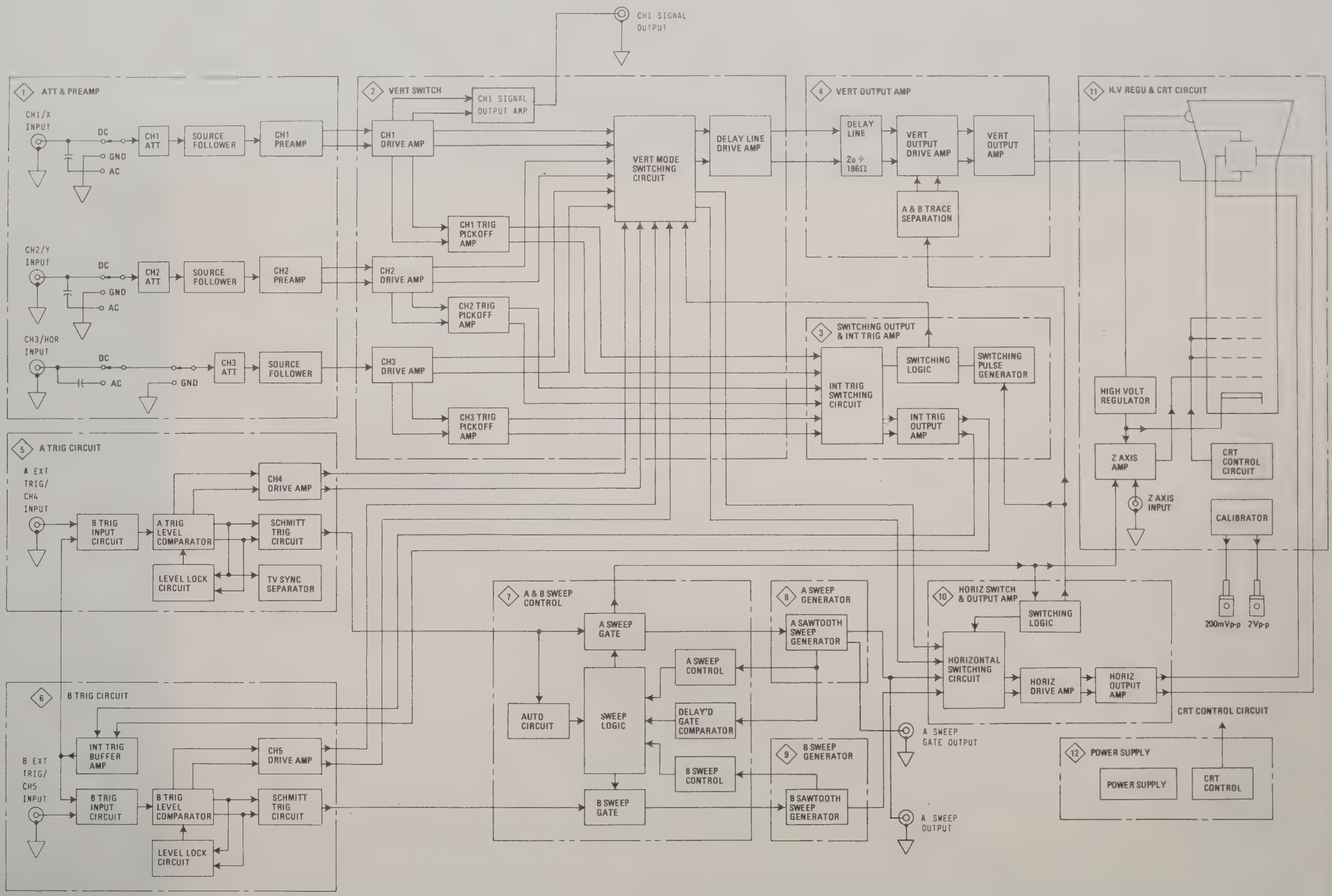
Diodes, transistors and ICs of type numbers different from those indicated but of equivalent characteristics may be used.
Unless otherwise indicated, resistance is given in ohms, 1/4W, 5%, carbon film and capacitor is given in farads.

*. Optimum value selected at factory. Average value shown.

(Parts may be omitted.)

△ Metal film resistor.

⊘ Screwdriver adjustment.



BLOCK DIAGRAM

X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11

Y8 Y7 Y6 Y5 Y4 Y3 Y2 Y1

ON ONEMYO

VOLTS / DIV

VARIABLE

PULL X5 MAG

CH1 INPUT

J-1

S101 AC GND DC

5mV 10mV 20mV 50mV 0.1V 0.2V 0.5V 1V 2V 5V 10V

S102-1 S102-2 S102-3

U101 CA3127E

U101 NO.5

Q101-1 2SK304

Q101-2 2SK304

QCR101 2SC1907

STEP BAL

DC BAL

Q102 2SA1206

Q103 2SA1206

VARIABLE

S103 S104

P-15 J-15

CR101 TLR102KW

UNCAL

X5 MAG GAIN

X5 MAG DC BAL

CH2 INPUT

J-2

S201 AC GND DC

5mV 10mV 20mV 50mV 0.1V 0.2V 0.5V 1V 2V 5V 10V

S202-1 S202-2 S202-3

U201 CA3127E

U201 NO.5

Q201-1 2SK304

Q201-2 2SK304

QCR201 2SC1907

STEP BAL

DC BAL

Q202 2SA1206

Q203 2SA1206

VARIABLE

S203 S204

P-16 J-16

CR201 TLR102KW

UNCAL

X5 MAG GAIN

X5 MAG DC BAL

CH3 INPUT

J-3

S301-1 AC DC

S301-2 GND

S301-3 1/10

Q301-1 2SK304

Q301-2 2SK304

QCR301 2SC1907

TO CH1

TO CH2

+12V +5V -12V

A 1

A 2

KIKUSUI ELECTRONICS CORPORATION

TITLE

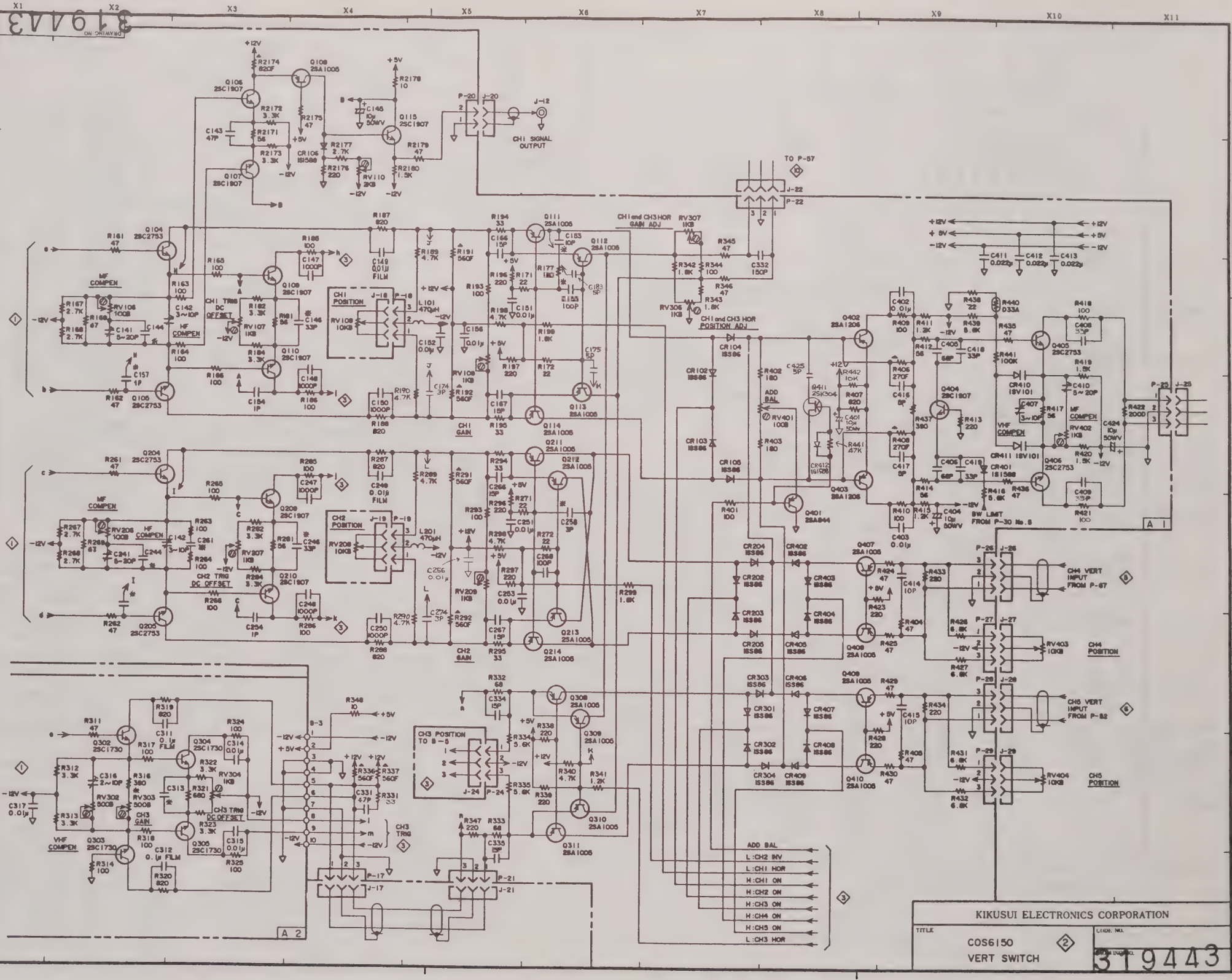
COS6150

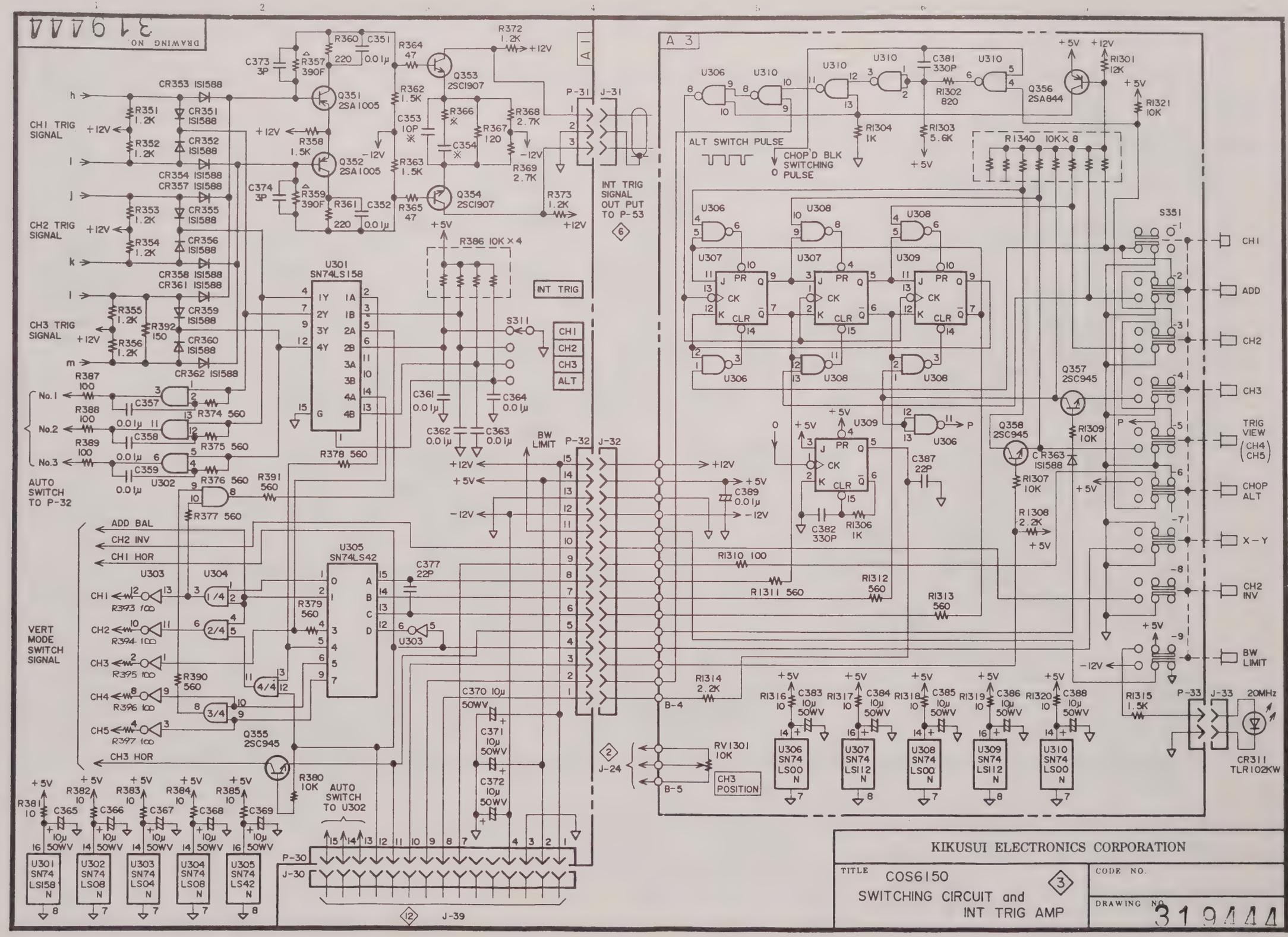
ATT and PREAMP

CODE NO

DRAWING NO 31-9442

31-9442


KIKUSUI ELECTRONICS CORPORATION
TITLE
COS6150
VERT SWITCH
DRAWING NO.
319443
CH1 SIGNAL OUTPUT
CH1 POSITION
CH1 GAIN
CH1 TRIG DC OFFSET
CH1 and CH3 HOR GAIN ADJ
CH1 and CH3 HOR POSITION ADJ
CH2 POSITION
CH2 GAIN
CH2 TRIG DC OFFSET
CH3 POSITION
CH3 GAIN
CH3 TRIG DC OFFSET
ADD BAL
CH4 VERT INPUT FROM P-67
CH4 POSITION
CH5 VERT INPUT FROM P-82
CH5 POSITION
BW LIMIT FROM P-30 No.8
TO P-67
L:CH2 INV
L:CH1 HOR
H:CH1 ON
H:CH2 ON
H:CH3 ON
H:CH4 ON
H:CH5 ON
L:CH3 HOR


DRAWING NO. 319444
CH1 TRIG SIGNAL
CH2 TRIG SIGNAL
CH3 TRIG SIGNAL
AUTO SWITCH TO P-32
INT TRIG SIGNAL OUT PUT TO P-53
INT TRIG
CH1
CH2
CH3
ALT
BW LIMIT
ADD BAL
CH2 INV
CH1 HOR
CH3 HOR
VERT MODE SWITCH SIGNAL
AUTO SWITCH TO U302
ALT SWITCH PULSE
CHOP'D BLK SWITCHING PULSE
TRIG VIEW (CH4 CH5)
CHOP ALT
X-Y
20MHz
CH3 POSITION
KIKUSUI ELECTRONICS CORPORATION
TITLE
COS6150
SWITCHING CIRCUIT and INT TRIG AMP
CODE NO.
DRAWING NO
319444

DRAWING NO. 319445

A 1

A 4

P-25 J-25

DL441
DELAY LINE

B-9
B-10

R441 91 C441 1P
R442 91 C442 1P

R443 330 ※
R444 470
R445 470

+5V
RV446 20KB
VERT CENTER
R498 10K

+12V
R460 270
R1441 10
R458 270F
Q445 2SC2753
R461 1.2K
R463 150
Q447 2SC945
R464 10K
R459 270F
Q446 2SC2753
R1442 10
R462 270
C463 2200P
+12V

+12V
Q448 2SC1907
R465 22
R466 560
C464 ※
R467 560
HF-1 COMPEN
R468 22
Q449 2SC1907
+12V

C460 ※
R494 10
R469 10
Q450 2SC2055 ※
Q451 2SC2055

C444 27P
C445 2~20P
C467 22P
C447 5~55P
C448 47P
C449 0.022μ
C446 2~20P
RV441 100B
RV442 2KB
RV443 20KB
RV444 50KB
R472 33
C462 100P
HF-2 COMPEN
HF-3 COMPEN
MF COMPEN
LF COMPEN

+5V
R473 680
R474 1.5K
CR445 1S1588
C450 0.01μ
R475 33 1/2
Q456 2SC2120

R471 33
R477 560
q
C469 5P
k
J
C468 220P

+21V
Q454 2SC1164
R482 47
R499 560
R483 560
C465 10μ 50WV
C452 0.01μ
CR444 HZ28-3
+12V
R484 47

C454 0.01μ
CR442 RD13JB
B-11
L443 0μH D=3.2 T=7
R491 100
R1443 100
TO CRT Y+

L441 1.2μH D=6 T=17
R485 220 2W
R489 22K 1W
R486 220 2W
+55V
+150V
C453 1000P
C455 1000P
R487 220 2W
R488 220 2W
R490 22K 1W
L442 1.2μH D=6 T=17

R1444 100
R492 100
TO CRT Y−
B-12
CR443 RD13JB
C456 0.01μ
L444 0μH D=3.2 T=7

Q455 2SC1164
R476 560
q

Q452 2SC1907
Q453 2SC1907
R478 47
R481 47
C451 22P
R479 3.9K
R493 100
R480 3.9K
−12V

X-Y ALIGN
RV445 100

P-34 J-34
FROM P-78
10

Q441 2SC945
Q442 2SC945
R452 5.6K
C443 0.01μ
R451 220
R450 47
R449 47
R448 100
R446 3.3K
R447 3.3K
CR441 1S1588
Q443 2SC945
R453 5.6K
R454 5.6K
Q444 2SC945
R456 6.8K
R457 5.6K
R455 1.2K
−12V

+12V +5V −12V
C495 10μ 50WV
C457 1000P
C458 1000P

−12V +5V +21V +12V
R496 10 +55V
R497 10 +150V
10 9 8 7 6 5 4 3 2 1
P-35
J-35
12

A 11

KIKUSUI ELECTRONICS CORPORATION

TITLE
COS6150 4
VERT OUTPUT AMP

CODE NO.

DRAWING NO. 319445

DRAWING NO 319146

A 7

CH4 PREAMP

A 6

TV SYNC SEP

A TRIG SCHMITT

A TRIG LEVEL and LOCK

J-69 P-69 J-70 P-70

A EXT TRIG and CH4 INPUT

LINE TRIG FROM (12)

C524 0.022μ FILM

R501 47

R502 56

S501-1 S501-2

SOURCE: INT / LINE / EXT / EXT +10

C501 2~10P

R503 800KD 1/2

C502 2~10P

R504 250KD

C503 22P

C583 3P

R551 100

Q581 2SC1730

CH4 GAIN

R553 3.9K

+12V

RV503 500

C582 1.5~4P

R555 390

R559 680F

R556 3.9K

-12V

R552 100

Q582 2SC1730

r s

R558 680F

C585 47P

R561 22

P-67 J-67

CH4 VERT SIGNAL OUTPUT TO P-26 (2)

S502-1 S502-2

COUPLING: AC / HF REJ / TV / DC

C504 0.022μ FILM

R505 47K

R563 10K

C505 47P

C506 2200P

R507 470K

R508 47

R506 1MD 1/2

C507 10μ 50WV

+5V

Q501-1 2SK105

Q501-2 2SK105

QCR501 2SC1907

R509 47

R511 47

R510 47

R512 5.6K

R513 5.6K

-12V

C508 10μ 50WV

C509 15P

R519 ※

C510 ※

R520 2.2K

R521 220

R522 2.2K

R523 100

R524 100

R526 330

R525 330

R514 470

R515 6.8K

U501 CA3127E

U503 CA3086

Q506 2SC1907

C517 33P

R541 56

R537 180

R539 220

R542 220

C516 10μ 50WV

R540 220

R538 180

R543 56

C518 33

Q507 2SC1907

R532 100

R533 100

Q502 2SA838

R527 100K

Q503 2SC1907

CR502 1S1588

R534 2.2K

R536 2.2K

R535 2.2K

R562 6.8K

Q508 2SC945

R544 10K

A SWEEP GATE

ALT SW PULSE

(8) FROM J-60 No.10 TV.V

J-62 P-62

HOLD OFF / LOCK / LEVEL / B ENDS A

R516 680

RV501-1 10K

-12V

HOLD OFF CONTROL TO R810

S503

RV501-2 100K

+12V

-12V

S504

C513 0.01μ

R531 1M

R530 1M

R529 1M

U502 TL081CP

C511 1μ TANTAL

C512 μ TANTAL

Q504 2SA838

Q505 2SC1907

R528 100K

Q503 2SC1907

CR503 1S1588

CR504 1S1588

CR505 1S1588

SLOPE

S505

C514 0.01μ

C515 0.01μ

+12V +5V -12V

C521 0.022μ C522 0.022μ C523 0.022μ

R591 4.7

C575 10μ 50WV

U504 MC10H 116

R592 4.7

R593 4.7

U704

C576 10μ 50WV

U505 MC10H 102

R572 2.2K

R571 1M

R574 560

R575 1.5K

R573 560

C572 0.047μ FILM

C573 0.1μ TANTAL

Q571 2SC945

C571 1μ TANTAL

R590 5.6K

Q572 2SC945

U504

R578 2.2K

R577 2.2K

R576 470

R590 100

VBB No.11 (7)

R579 470

R580 220

U504

R581 470

R582 220

U505

R584 2.2K

U505

HD1013 No.11 (7)

U505

C574 22P

R585 220

Q573 2SA838

R587 1.5K

CR571 1S1588

R586 10K

R588 2.2K

R589 2.2K

TO R701 AUTO TRIG (7)

KIKUSUI ELECTRONICS CORPORATION

TITLE: COS6150 (5) A TRIG CIRCUIT

CODE NO

DRAWING NO 319146

DRAWING NO 319447

TO J-69 J-54 P-54

J-5 J-55 P-55

B EXT TRIG and CH5 INPUT

R611 47

R610 68

R609 47

S601-1 S601-2

SOURCE

STARTS AFTER DELAY
INT
EXT
EXT÷10

C611 2~10P

R612 800KD 1/2

C612 2~10P

R613 250KD

C613 33P

R653 33

INT TRIG SIGNAL INPUT FROM P-31 ③

J-53 P-53

C618 0.01μ

+5V

Q603 2SC1907

R604 390

R601 47

R606 1.2K

R608 1K

-12V

Q601 2SA1005

Q602 2SA1005

R603 150

R607 1.2K

R602 47

R605 390

+12V

R654 470K

Q604 2SA844

R652 10K

Q605 2SC1843

A 8

R661 100

Q613 2SC1730

CH5 GAIN

R665 3.9K

RV661 500

R663 390

R666 3.9K

Q614 2SC1730

R662 100

R668 680F

C665 47P

R669 680F

※R671 22

C662 1.5~4P

P-52 J-52

CH5 VERT SIGNAL OUTPUT ②

COUPLING

S602-1 S602-2

C614 0.022μ FILM

C615 47P

R614 47K

R615 100K

C616 47P

AC

LF REJ

HF REJ

DC

C617 2200P

R618 47

R617 470K

R616 1MΩ 1/2

C619 10μ 50WV

Q606-1 2SK105

QCR601 2SC1907

C620 10μ 50WV

R620 47

R622 5.6K

R623 5.6K

-12V

U601 CA3127E

R619 47

R621 47

Q606-2 2SK105

R628 ※

R629 150

C621 15P

C622 ※

R630 2.2K

R631 2.2K

R633 100

R635 330

R634 330

U603 CA3086

R632 100

R646 180

R647 180

R648 220

R649 220

R651 56

R655 2.7K

C630 33P

Q612 2SC1907

Q611 2SC1907

C629 33P

R650 56

C628 10μ 50WV

A 6

J-49 P-49

R686 330Ω

CR681 1SS86

B TRIG

R681 470

R683 220

U604

HD10116 1/3

C682 1P

R682 470

R684 220

B TRIG SCHMITT

A/B TRACE SEP

LEVEL

LOCK

RV601-1 10K

RV601-2 100K

S603

R625 6.8K

R624 470

C625 0.01μ

R639 1M

R638 1M

R640 1M

U602 TL081CP

Q607 2SA838

R636 100K

Q609 2SA838

Q608 2SC1907

R637 100K

Q610 2SC1907

C624 1μ TANTAL

C623 1μ TANTAL

R641 100

R642 100

R643 2.2K

R645 2.2K

R644 2.2K

C626 0.01μ

C627 0.01μ

B SWEEP GATE

B TRIG 'D and CH5 ON

R685 4.7

C681 10μ 50WV

U604 MC10H 116

C667 10μ 50WV

C668 10μ 50WV

SLOPE S604

B TRIG LEVEL and LOCK

A/B TRACE SEP CONTROL TO J-43 No.8 ⑫

C669 0.022μ

C670 0.022μ

C671 0.022μ

KIKUSUI ELECTRONICS CORPORATION

TITLE

COS6150

B TRIG CIRCUIT ⑥

CODE NO

DRAWING NO 319447

KIKUSUI ELECTRONICS CORPORATION

TITLE: COS6150 A/B SWEEP CONTROL (7)

CODE NO.

DRAWING NO. 319248

DELAY TIME COMPARATOR

DELAY TIME MULT

A SWEEP GATE

B SWEEP GATE

B SWEEP LENGTH

A SWEEP LENGTH

ALT SWITCH PULSE TO R1009

B SWEEP GATE TO R1043

A INTEN GATE

B TRIG

A TRIG

A SWEEP OUT TO R1001

B SWEEP OUT

START LEVEL

DT START ADJ

DT END ADJ

AUTO TRIG U505 No.3

SINGLE PUSH TO RESET

NORM

AUTO

READY CR711 TLR102KW

TRIG'D CR710 TLG102KW

DRAWING NO. 319248

DRAWING NO. 319449

P-62 J-62 P-61 J-61 P-60 J-60 A6

A SWEEP START COMPARATOR

A SWEEP J-14 J-64 P-64 R803 33K -12V R802 10K

A SWEEP GATE J-13 J-65 P-65

+12V R804 1K R806 100 R807 4.7 R808 22

Q801 2SA844 Q802 2SA 1005 Q803 2SA844

C801 0.01μ R805 100

+55V R814 39K 1/2 R815 470K +12V

Q805 2SA844 CR804 ISI588 C804 1μ 50WV

+5V R816 470K +5V Q806 2SA844 CR805 ISI588 C805 0.01μ

Q804 2SA838 R811 2.2K CR802 ISI588 CR803 ISI588

CR806 ISI588 CR807 ISI588 C806 220P

R812 1.8K C808 220p Q807 2SC945

R813 2.7K C807 1000P CR808 ISI588 R817 2.7K

-12V +5V

LINE TRIG HOLD OFF +12V R848 5.6K Q822 2SA844

R809 390 CR801 ISI588 R810 10K

⑤ HOLD OFF CONT FROM RV501

+12V R855 220 R819 3.9K R820 1K R821 150

Q809 2SA844 Q808 2SC1907 CR809 ISI588

C819 47μ 25WV -12V

U802 C812 0.01μ FILM C811 1μ 200WV R818 3.3K -12V

RV802 10K 0.1S ADJ RV801 10K 1mS ADJ

+12V +5V +12V R824 5.6KF R826 10KF Q813 2SC945 U802

R825 5.6K C820 0.01μ R827 3.3K Q814 2SA844

+55V R831 220 R828 50KD R829 20KD R830 10KD

Q815 2SA844 2SA844 Q816

R857 82 C813 82P C814 2~20P R822 100 +5V

Q810 2SA838 Q811 2SK107 Q812 2SC1907 R823 5.6K -12V

Q817 2SC945 C817 0.01μ R832 1K U801 TL081CP

R833 1MD1/2 R834 100KD R835 10KD R836 990D

R838 4.7K R837 1.07KF R856 1.5K +5V

Q818 2SC 945 Q819 2SC 945 Q820 2SC 945 Q821 2SC 945

C816 10μ 50WV R839 6.8K R840 6.8K R841 6.8K R842 3.3K CR814 HZ3C2 -12V

A SWEEP TIMING R/C SWITCH

+12V R851 10 R852 10 R853 10

U802 TC40 66BP U803 TC40 09P U804 TC40 23P U805 TC40 30P

A SWEEP

P-73 J-73 B-19 TO S801 5 4 3 2 1

P-74 J-74 UNCAL CR810 TLR102KW

RV803 10K S803 A15 VARIABLE

U805 U803 U804 CR811 ISI588 CR812 ISI588 CR813 ISI588

R843 22K R844 22K R845 22K R846 12K

A7 R847 100K X 10 P-66 J-66

A/B TIME/DIV AND DELAY TIME

⑨ S802 S801-1 S801-2

A SWEEP VARIABLE

CH3 HOR
0.5 S
0.2
0.1
50 mS
20
10
5
2
1
0.5
0.2
0.1
50 μS
20
10
5
2
1
0.5
0.2
0.1
50 nS
20

KIKUSUI ELECTRONICS CORPORATION

TITLE ⑧ COS6150 A SWEEP GENERATOR

CODE NO.

DRAWING NO. 319449

KIKUSUI ELECTRONICS CORPORATION

TITLE: COS6150 B SWEEP GENERATOR ⑨

CODE NO

DRAWING NO. 319450

B SWEEP START COMPARTOR

B SWEEP

B SWEEP TIMING R/C SWITCH

1MS ADJ

0.1S ADJ

+55V
+12V
+5V
-12V

A/B TRACE SEP
B TRIG VIEW
CH3 HOR SW
CH1 HOR SW
CH3 AUTO SW
CH2 AUTO SW
CH1 AUTO SW

R930 100K × 10

S802-1 S802-2

0.5 S 0.2 0.1 50 ms 20 10 5 2 1 0.5 0.2 0.1 50 μS 20 10 5 2 1 0.5 0.2 0.1 50 nS 20

A/B TIME/DIV AND DELAY TIME

DRAWING NO. 319450

DRAWING NO. 319451

POSITION
CROSE FINE
RV1001 10KB
RV1002 10KB
VARIABLE
PULL × 10MAG
SI002
A 15
J-58
P-58
J-59
P-59
A START
RV1003 1KB
RI020 3.9K
RI021 27K
RI002 1.8KF
A SWEEP
RI001 1.8KF
Q1001 2SA844
Q1003 2SA844
RI005 100
CRI001 1S1588
CRI002 1S1588
RI008 2.2K
B START
RV1004 1KB
RI004 1.8KF
B SWEEP
RI003 1.8KF
Q1002 2SA844
Q1004 2SA844
CRI003 1S1588
CI001 47μ 25WV
RI007 100
CI002 47μ 25WV
RI006 2.2K
× 10 MAG GAIN
RV1005 100B
RI041 47
CI006 ※
RI022 390F
RI023 3.9KF
RI024 3.9KF
Q1006 2SA1015
Q1007 2SA1015
RI025 3.9KF
RI026 1.2K
RI027 3.9KF
CRI005 1S1588
CRI006 1S1588
Q1008 2SC1907
Q1009 2SC1907
RI030 820
CI007 0.01μ
RI031 1KF
RI028 820
CI008 0.01μ
RI029 1KF
RI045 2.2K
RI018 3.3KF
RI019 390F
Q1010 2SA844
Q1011 2SA844
RI032 330
RI033 4.7K
RI034 1.5K
RI042 10K
Q1012 2SA844
Q1013 2SA844
RI035 2.2K
RI036 3.9K
RI037 47
RI038 47
CI005 47μ 25WV
Q1014 2SC945
RI044 10
CI012 10μ 50WV
U1001 SN74 LS00N
U1002 SN74 LS74N
CH1(X) and CH3 HOR INPUT
A 6
P-57
J-57
P-56
J-56
CH1 and CH3 HOR SWITCH
U1001 No.3
RI043 6.8K
RI040 10K
SI001
A
B
A INT
ALT
B GATE TO U707 No.7
RI017 A INTEN GATE to U708 No.12
100
CI011 100P
CI003 47P
RI015 1K
U1002 PR Q CK D CL Q̄
RI013 10K
RI014 10K
U1001
ALT(L) CHOP(H)
VERT ALT SW PULSE
RI039 10K
CI009 0.01μ
RI012 680
Q1005 2SA838
ALT SWITCH PULSE U705 No.3
RI009 330
RI010 150
RI011 1K
CI015 0.1μ
CI014 0.1μ
CI016 0.1μ
CI013 0.01μ 500WV
to J-60 No.10
to J-60 No.9
to J-60 No.8
P-47
J-47
A 8
A 9
A 11
HOR RIMIT
RV1051 2KB
CI077 0.01μ
20nS COMP
RV1052 5KB
CI058 0.47P G-CCN
RI077 47K 1W
RI090 68K 1W
RI086 22
to CRT X+
P-76
J-76
Q1061 2SD668A
Q1063 2SB648A
CI066 0.047μ 250WV
RI085 330
RI067 2.2K
RI068 220
CI054 ※ 100P
CI056 0.01μ
Q1055 2SC1907
Q1057 2SA-1005
RI071 1K
RI075 2.2K
Q1059 2SC-945
RI081 150K
CI061 10μ 50WV
CI063 0.01μ 500WV
RI083 1K
+150V
CRI053 HZ2B-3
CI068 0.1μ
QCR1051 2SC1730
QCR1052 2SC1730
RI095 100
RI072 33K
RI073 33K
RI078 2.2K
Q1058 2SA-1005
RI079 2.2K
CI060 10μ 50WV
CI064 0.01μ 500WV
CI065 0.01μ 500WV
RI082 150K
RI084 1K
CI062 10μ 500WV
CI055 100P
RI069 220
RI070 2.2K
Q1056 2SC1907
RI096 2.2K
RI076 2.2K
Q1060 2SC-945
CI067 0.047μ 250WV
RI087 330
RI074 1K
CI057 2~20P
2nS COMP
Q1062 2SD668A
Q1064 2SB648A
RI080 47K 1W
RI091 68K 1W
RI088 22
to CRT X−
P-77
J-77
RI062 47
Q1053 2SC1907
RI060 1.5K
RI065 3.9K
RI089 12K ※
CI078 ※
RI064 1.2K
RI066 3.9K
Q1054 2SC1907
RI063 47
RI061 1.5K
CI059 0.47P G-CON
CI051 0.01μ
RI056 100
RI053 470F
RI097 47K
XIO MAG BAL
RV1053 20KB
RI058 3.3K
Q1051 2SA1005
RI059 1.2K
Q1052 2SA1005
RI051 47
RI054 1K
RI052 47
CI052 0.01μ
RI057 100
RI055 470F
Q1065 2SC1907
RI093 100
RI092 47
to P-34
RI094 3.9K
P-78
J-78
+150V +12V +5V −12V
CI074 0.1μ
CI073 0.1μ
CI072 0.1μ
CI071 0.01μ 500WV
CI075 0.01μ
CI076 10μ 50WV
P-75
J-75
J-42
P-42
BEAM FIND
KIKUSUI ELECTRONICS CORPORATION
TITLE
COS6150
HOR SWITCH and OUTPUT AMP
10
CODE NO
DRAWING NO. 319451

DRAWING NO 319452

A 10

+12V

R1101 10

HV ADJ

RV1101 10KB

R1102 5.6KF

CR1112 1S1588

CR1101 1S1588

R1103 5.6KF

C1101 10μ 50WV

R1107 220K

R1108 680

R1104 56KF

Q1101 2SA844

Q1102 2SC1834

Q1103 2SA844

R1113 33

C1102 1μ TAN TAL

C1103 0.047μ FILM

R1106 47

R1109 22K

+21V

C1104 100μ 25WV

R1110 1K

R1111 1K

R1112 2.2 1/2

Q1104 2SA844

C1105 100μ 25WV

y

C1119 22P 2KV

T1101

CR1102 GHV-06

R1116 22K 1/2

C1107 4700P 3.15KV

C1108 4700P 3.15KV

C1109 4700P 3.15KV

J-80 P-80

Q1105 2SD880

R1105 100

C1106 4700P 3.15KV

R1114 R1115 10MF 3W 10MF 3W

DC-DC CONVERTOR

A 12

H·V MULTI

B-20 B-21 B-22

C1121 C1123 C1125 C1127 C1129

CR1121 CR1123 CR1125 CR1127 CR1129

CR1122 CR1124 CR1126 CR1128 CR1130

C1122 C1124 C1126 C1128 C1130

R1130 10M 1/2

C:1000P 6KV D:GHV-06

R1118 1M 1/2

R1119 2.2M 1/2

CR1103 1SS83

R1120 150K

CR1104 RD24JB

C1120 0.01μ 500WV

+150V

C1113 1000P 6.3KV

R1126 10M 1/2

R1127 10M 1/2

R1121 10MF 3W

RV1102 2.2M

SUB FOCUS 6.3KV

CR1110 1SS83

CR1111 1SS83

C1104 1000P

C1115 1000P 6.3KV

C1110 1000P 6.3KV

CR1105 ERB26-20

CR1106 1SS83

CR1107 1SS83

R1122 10M 1/2

R1123 10M 1/2

C1111 1000P 6.3KV

R1124 2.2M 1/2

C1112 1000P 6.3KV

R1125 3.3K

Z1101 ERZ-CID DK-361

R1131 100

CR1108 1SS83

CR1109 1SS83

R1132 100

R1128 1K

V1101 NE-9888

V1102 NE-9888

+12V +21V +150V

ASTIG HALATION

+150V Q1106 2SC2371

R1133 100K

RV1103 100K

RV1104 100K

RV1105 100K GEOMETRY

C1116 0.01μ 500WV

C1117 0.01μ 500WV

C1118 0.01μ 500WV

P-84 J-84

P-83 J-83

P-82 J-82

P-81

V1103

SIDE 1

SIED 2

12 P.T

P-79 J-79

+12V +21V +150V

A 11

C1145 0.47P G-CON

C1160 +12V 0.01μ

R1154 3.3K

Q1147 2SC1907

R1156 33K

R1157 560

R1159 56K 1W +12V

Q1151 2SC-1907

Q1153 2SD668A

Q1155 2SB648A

R1169 47

R1180 10K

CR1148 1Z150

FOCUS

C1162 1000P

C1150 0.01μ 500WV

R1168 470

C1148 0.01μ

C1151 0.01μ 500WV

R1166 1K

CR1146 HZ2B-3

C1154 0.1μ

R1171 10

+150V

+12V SUB INTEN ADJ

RV1141 10KB

R1151 10K

Q1145 2SC1907

R1148 220

R1150 220

C1142 68P

CR1144 1S1588

CR1145 1S1588

R1149 220

R1173 1.8K

-12V

Q1146 2SC1907

R1152 100

C1163 10P

RV1142 10KB

Q1149 2SA-844

R1160 2.2K

R1162 2.2K

R1163 2.2K

C1158 10μ 50WV

C1147 0.01μ 500WV

R1164 150K

R1165 150K

R1167 1K

C1149 0.01μ

C1152 0.01μ 500WV

CR1147 1S1588

Q1150 2SA-844

C1144 2~10P

R1146 2.2K

C1143 0.01μ

+5V

R1153 100

Q1148 2SC1907

C1164 22P

R1155 3K

R1158 560

R1161 2.2K

Q1152 2SC-1907

R1174 68K 1W +12V

C1146 0.47P G-CON

C1153 0.01μ 500WV

C1159

Q1154 2SD668A

Q1156 2SB648A

R1170 470

R1172 47

C1161 10μ 50WV

+5V

+12V

R1141 4.7K

Q1141 2SA838

R1176 560

CHOP'D BLK

CR1142 1S1588

R1142 1K

Q1142 2SA838

R1177 100

UNBLK SIGNAL

R1145 3.9K

Q1143 2SC945

CR1141 1S1588

Z AXIS INPUT

J-86 P-86

R1143 5.6K

R1144 5.6KF

-12V

C1141 10μ 50WV

R1079 10

R1078 10

C1155 C1156 C1157 0.01μ 0.01μ 0.01μ

FOCUS and Z AXIS AMP

A 5

R1182 100

R1183 10K

U1101

R1186 10K

R1187 12K

+12V

Q1202 2SA1015

R1189 1.2K

RV1182 2KB

C1184 10P

CAL OUT ADJ

R1190 9.1KF

C1187 100P

R1181 47K ※

RV1181 100KB

CAL FREQ ADJ

R1184 10K

C1181 0.01μ J

C1182 0.01μ J

R1185 100K

R1191 1.8KF

R1192 200Ω

R1193 10

C1185 10μ 50WV

U1101 TC4011BP

P-38 J-38

CALIB

J-8 200mV 2V J-7

KIKUSUI ELECTRONICS CORPORATION

TITLE

COS6150

HV REGU and CRT CIRCUIT

11

CODE NO

DRAWING NO 319452

KIKUSUI ELECTRONICS CORPORATION

TITLE	POWER SUPPLY and CRT CONTROL
	COS6150 (FAN)
CODE NO.	⟨12⟩
DRAWING NO	

	DATE	APP. BY	REV. BY
△	'85.10.2	M.S	M.Suzuki
△	. . .		
△	. . .		

CONTENTS

DRAWING NO.

DRAWING NO 319453

P-89
LINE
J-90
P-90
L E N
C1202 1000P 250VAC
C1201 1000P 250VAC
FUSE 1A
F1201
J-89
115V
100V
0
115V
100V
0
J-37
P-37
A 5
SI201
POWER
SI203
+12V
R1201 5.6K
Q1201 2SC945
RV1201 5KB INTEN
(PUSE TO BEAM FINDER) -12V +160V
R1202 10K
RV1202 10KB
B INTEN
RV1203 100KB
FOCUS
R1203 1K
+12V
RV1204 5KB
TRACE ROTATION
-12V
J-96
BRN
RED
R1204 1.5K
CRI201 TRG-105
DSI201 6.3V 0.15A
DSI202 6.3V 0.15A
DSI203 6.3V 0.15A
RV1205 5KB
ILLUM
T1201
6.3V CRT HEATER
45V
0
45V
60V
0
60V
18V
0
18V
10V
A 11
R1212 2.2M 1/2
LINE TRIG
C1211
0.022µ FILM
R1245 100K
R1211 2.2M 1/2
CR1211 SIVB40
C1213 100µ 160WV
CR1214 V06G
CR1215 V06G
C1216 220µ 100WV
CR1217 2D4841
C1219 2200µ 25WV
C1218 2200µ 25WV
C1220 2200µ 25WV
C1229 2200µ 16WV
CR1218 2D4841
J-88
P-88
J-87
P-87
J-92
Q1211 2SC1505
Q1212 2SB834
Q1215 2SB834
Q1216 2SD880
J-94
R1213 10K 1/2
R1214 4.7
R1219 1K
R1216 560
R1217 47KF
+12V
Q1213 2SC2371
CR1213 V06G
C1214 1µ 160WV
R1215 100KF
+150V
C1237 2200P
C1239 1µ 160WV
CR1212 V06G
R1218 47K
U1211 µPC4558C 2/2
R1222 56KF
C1217 1µ 160WV
+55V
CR1216 1SI588
R1223 12KF
-12V
R1220 1K
R1221 10
Q1214 2SA844
C1236 0.01µ
+21V
R1224 68 2W
R1226 2.2 1/2
C1223 10µ 50WV
R1228 680F
R1225 150
R1227 2.2 1/2
+12V ADJ
R1211 1KB
C1224 1000P
R1229 1.5K
C1221 ※
C1222 ※
U1212 TA7179P
C1225 1000P
R1230 12KF
C1226 0.01µ
R1234 150
R1232 2.2 1/2
R1231 12KF
R1235 68 2W
R1233 2.2 1/2
-12V
C1228 10µ 50WV
-21V
R1236 68 2W
Q1218 2SD880
J-93
R1238 1 1W
+5V
R1239 1K
Q1217 2SC945
R1241 3.9KF
C1230 ※
R1243 10K
R1240 220
U1211 µPC4558C 1/2
R1242 9.1KF
-12V
Q1219 2SD880
J-41
P-41
B-14
+150V
+12V
-12V
BEAM FINDER
B INTEN CONTROL
INTEN CONTROL
FOCUS CONTROL
J-36
P-36
TRACE ROTATION COIL
J-40
P-40
B-13
-21V
P-35
J-35
+150V
+55V
+21V
+12V
+5V
-12V
C1240 10µ 50V
C1233
C1231 0.01µ 500WV
C1232 0.01µ 500WV
C1234 0.1µ
C1235 0.1µ
BEAM FINDER
CHOP'D BLK
P-39
J-39
A1 J-32
P-43
J-43
A8 J-46
NC
P-44
J-44
B INTEN CONTROL
INTEN CONTROL
INTEN SIGNAL
LINE TRIG
TV.V
-12V
+5V
+12V
+55V
A8 J-45

KIKUSUI ELECTRONICS CORPORATION

TITLE
COS6150 ⟨12⟩
POWER SUPPLY and CRT CONTROL

CODE NO.

DRAWING NO. 31945

10. ELECTRICAL PARTS LOCATIONS ON CIRCUIT BOARD ASSEMBLY

A1 VERT PREAMP ..... [1] 167

A2 CH3 PREAMP ..... [1] 167

A3 VERT SWITCHING CONTROL ..... [2] 169

A4 VERT OUTPUT AMP ..... [2] 169

A5 CAL & CRT CONTROL ..... [2] 169

A6 TRIG & SWEEP CONTROL ..... [3] 171

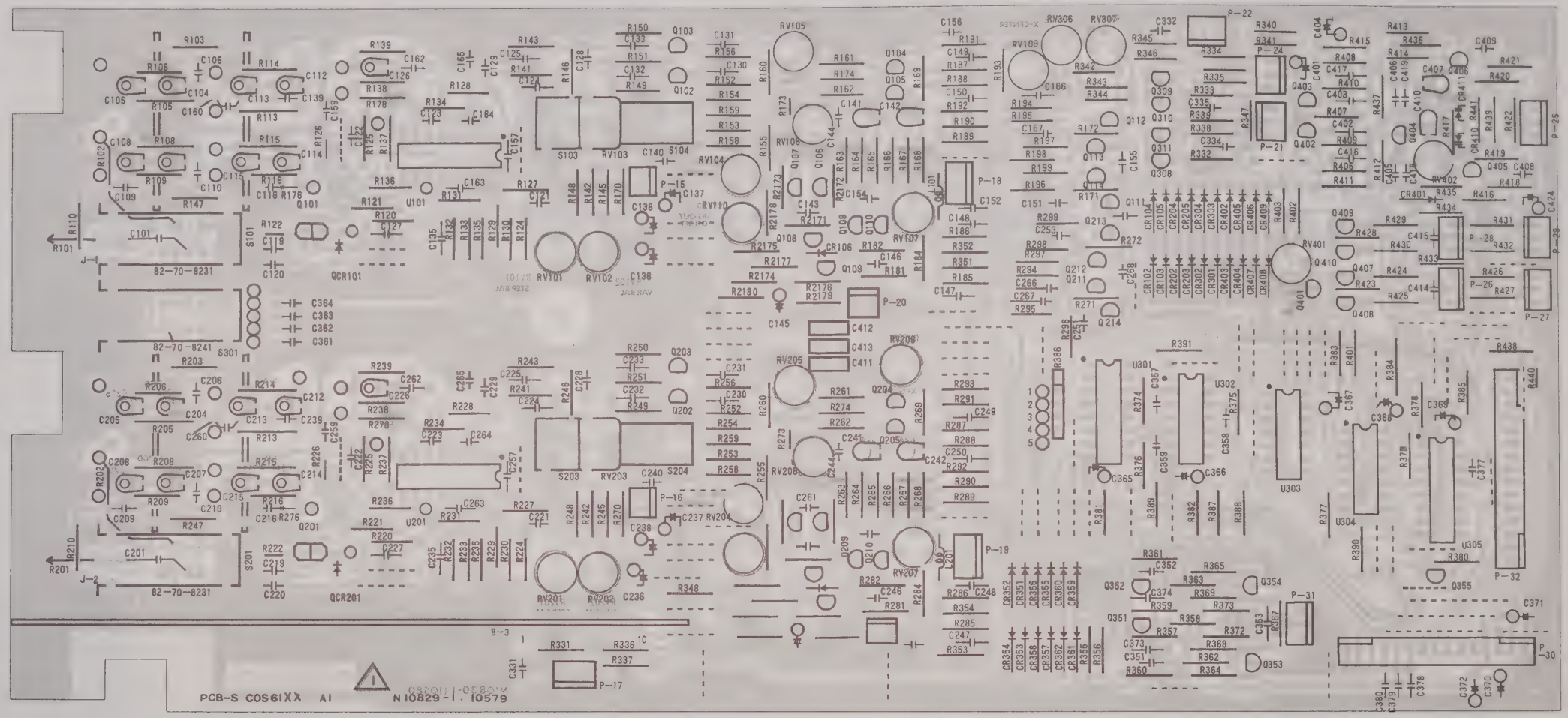
A7 A TRIG & A SWEEP ..... [3] 171

A8 B TRIG & B SWEEP ..... [3] 171

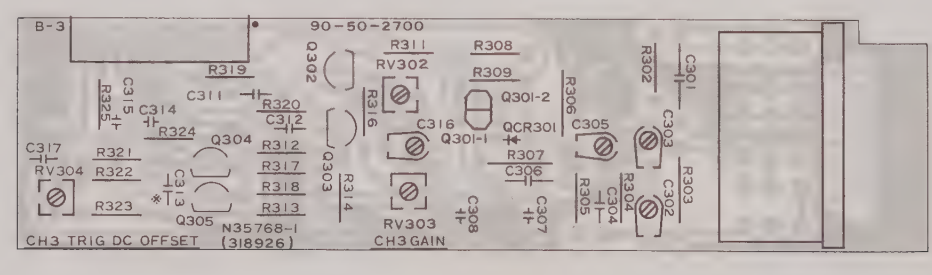
A9 HORIZ OUTPUT AMP ..... [4] 173

A10 H.V REGU. & CRT CIRCUIT ..... [4] 173

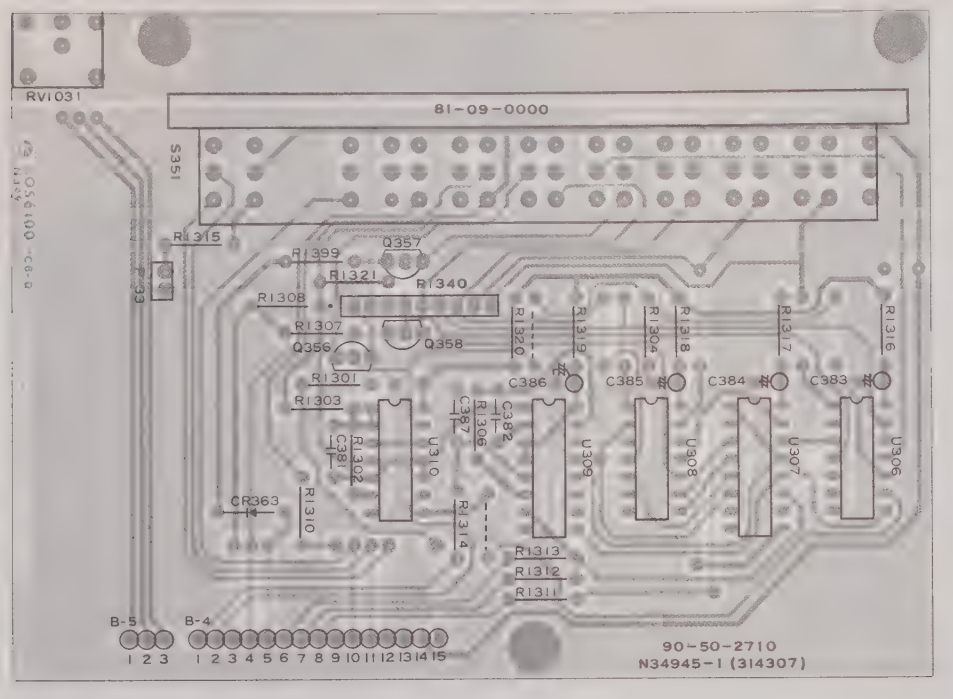
A11 POWER SUPPLY & Z AMP ..... [4] 173



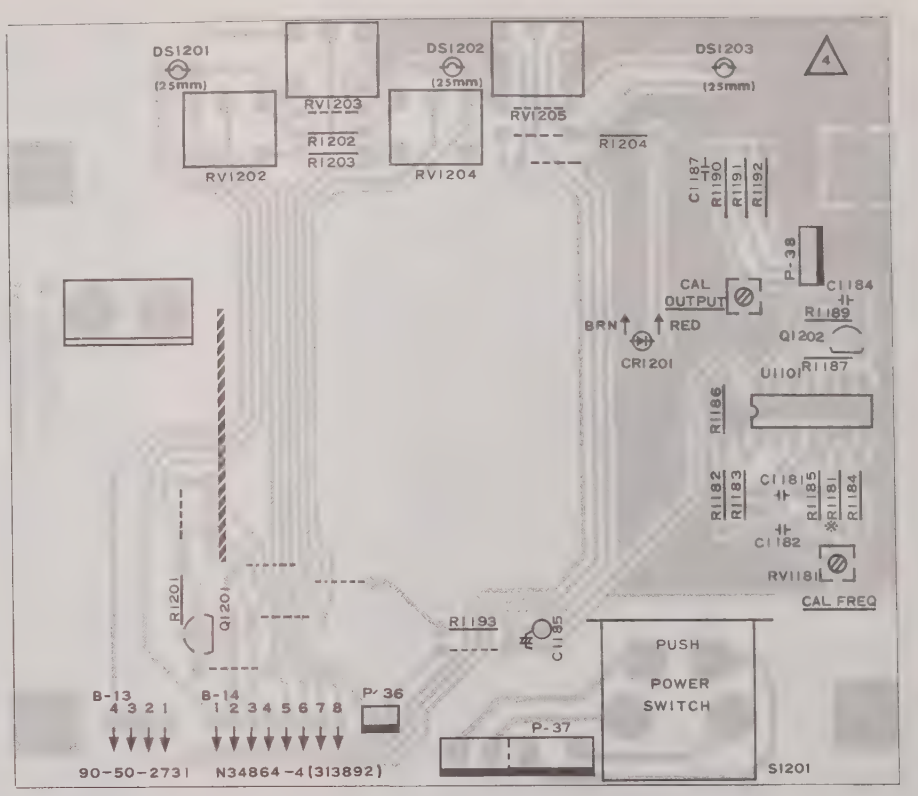
A1 VERT PREAMP Parts Location



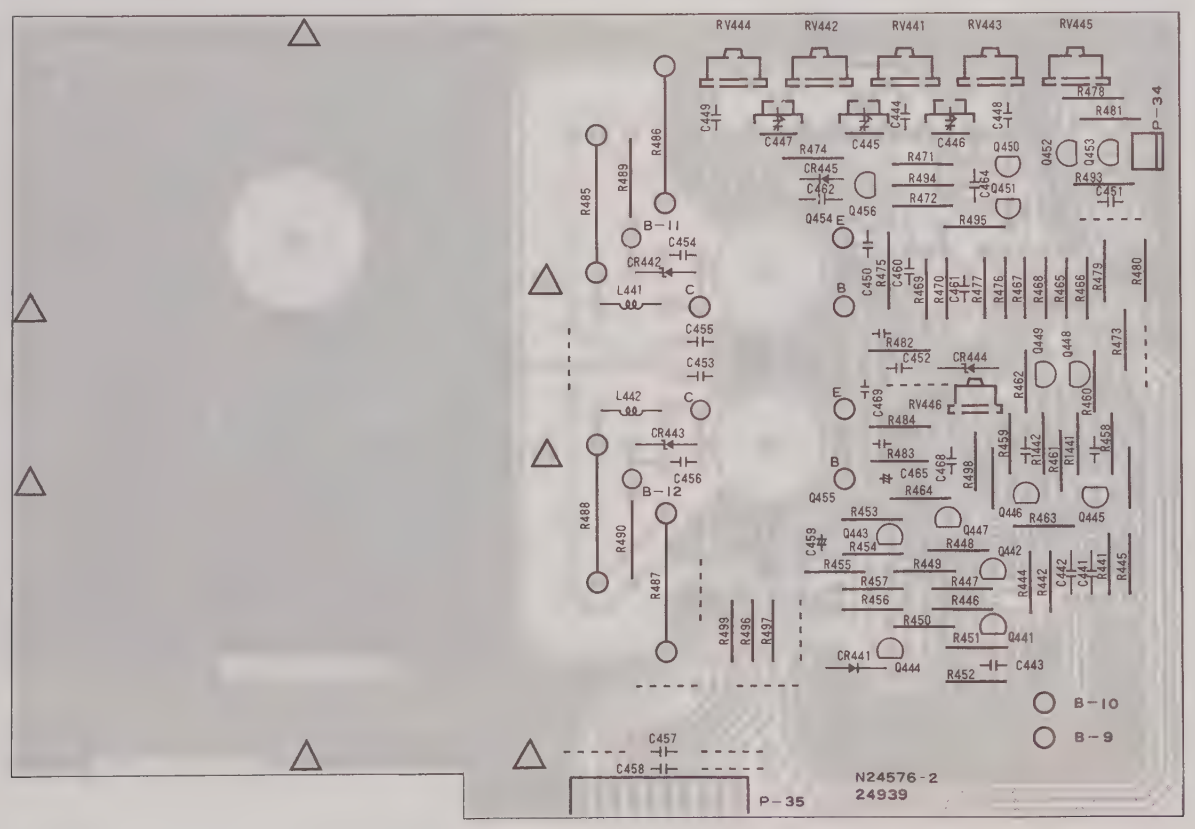
A2 CH3 PREAMP Parts Location



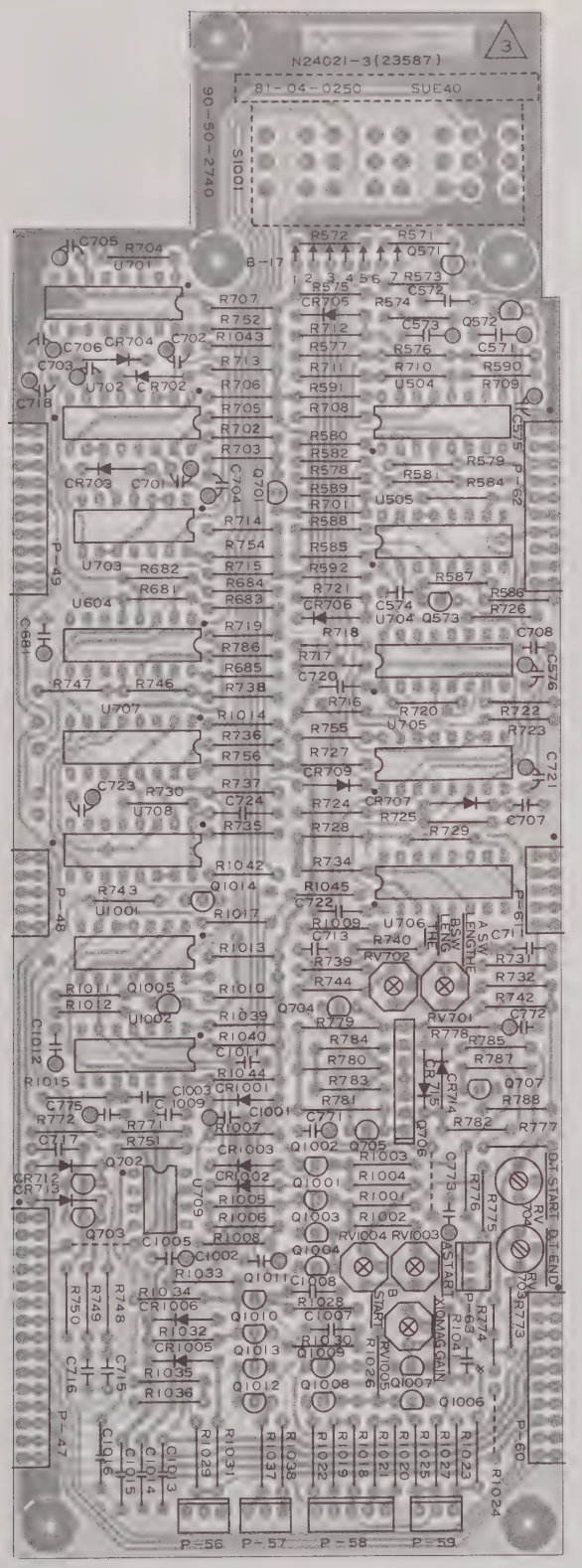
A3 VERT SWITCHING CONTROL Parts Location



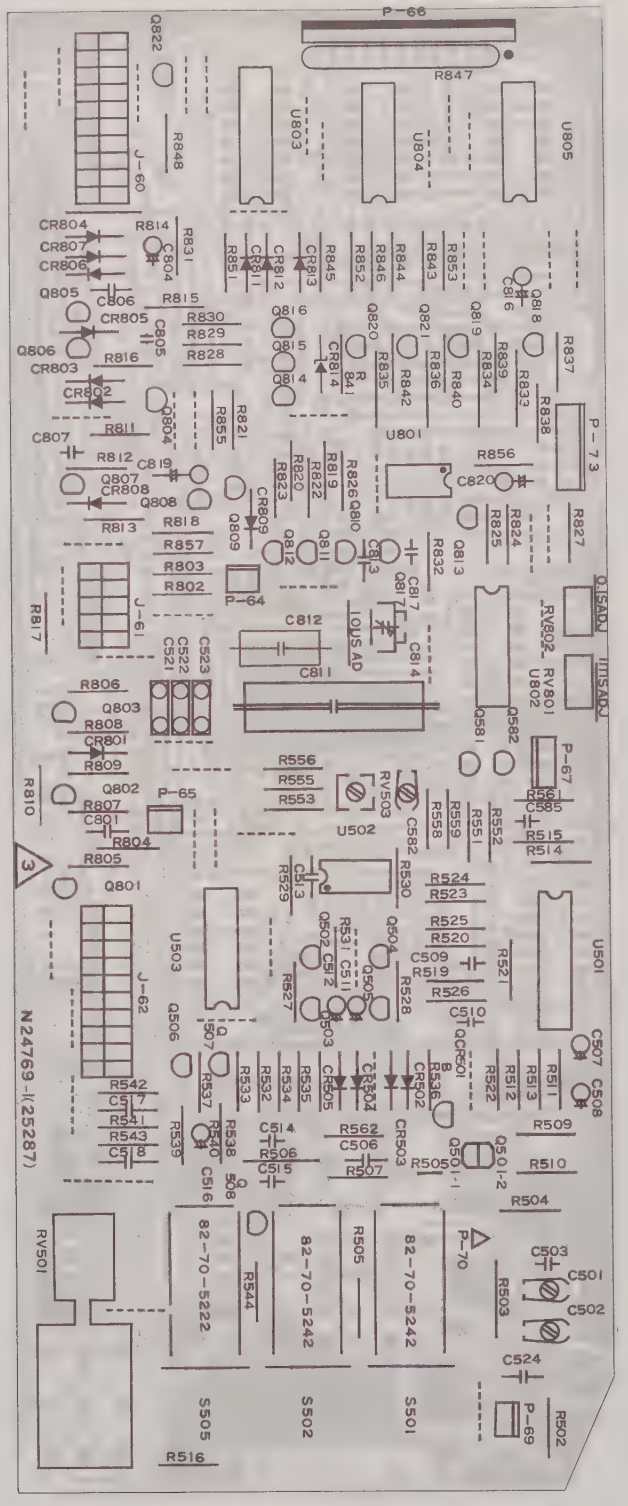
A5 CAL & CRT CONTROL Parts Location



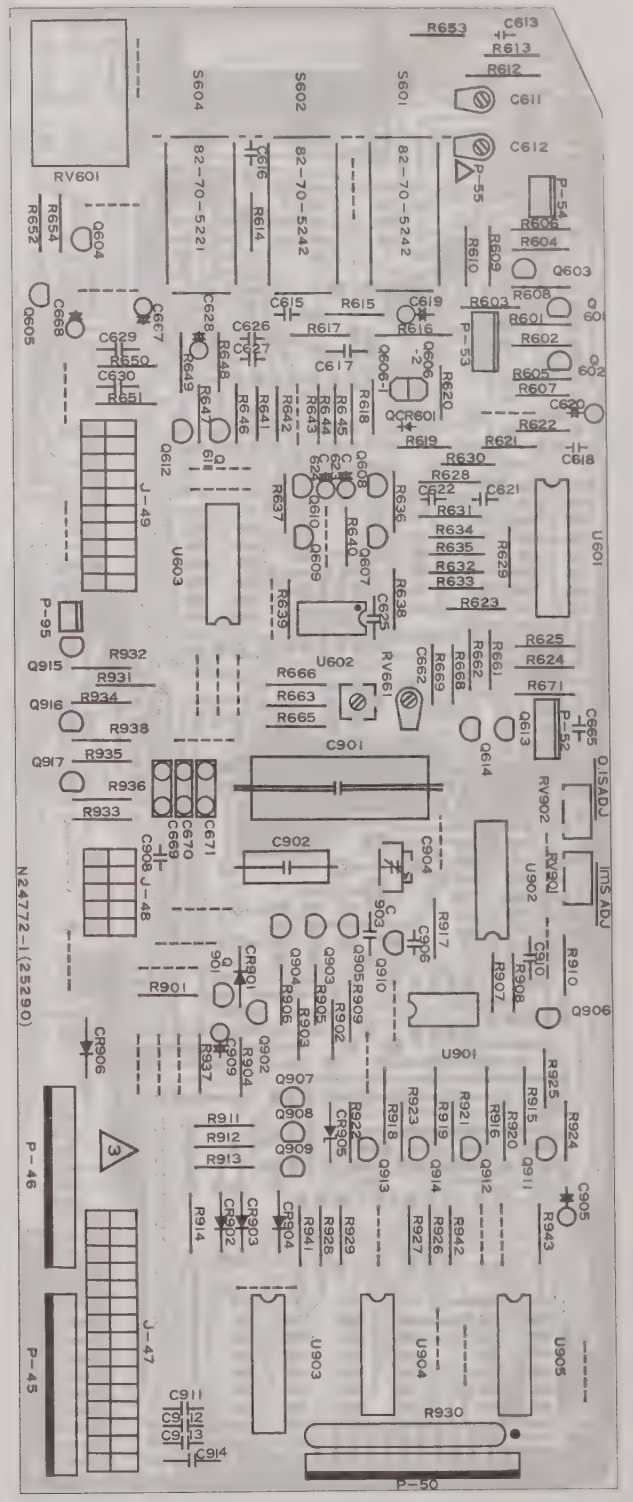
A4 VERT OUTPUT AMP Parts Location



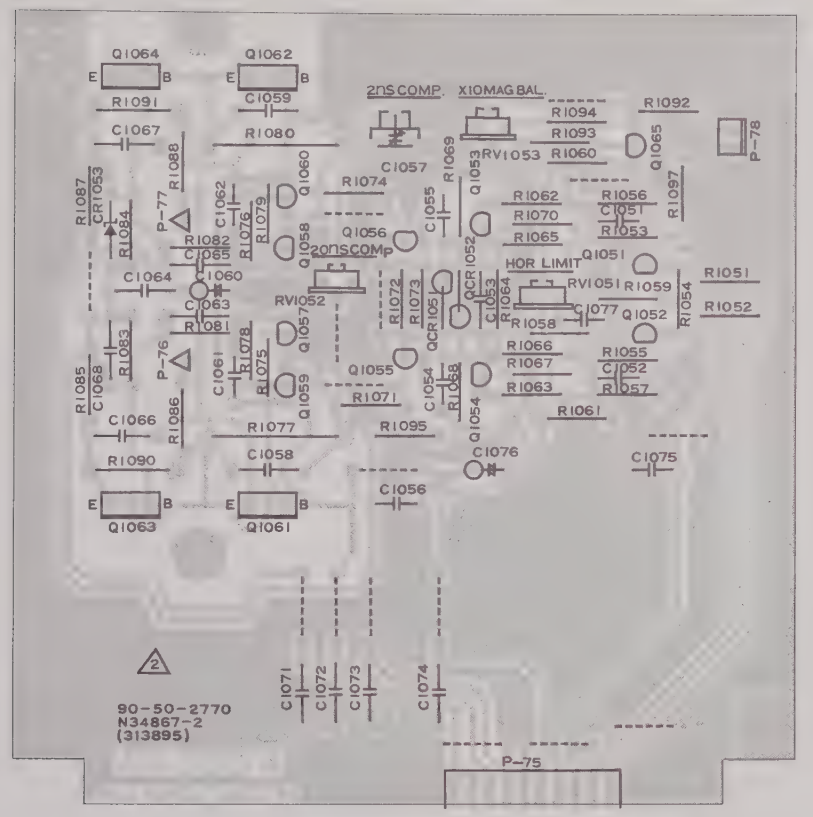
A6 TRIG & SWEEP CONTROL Parts Location



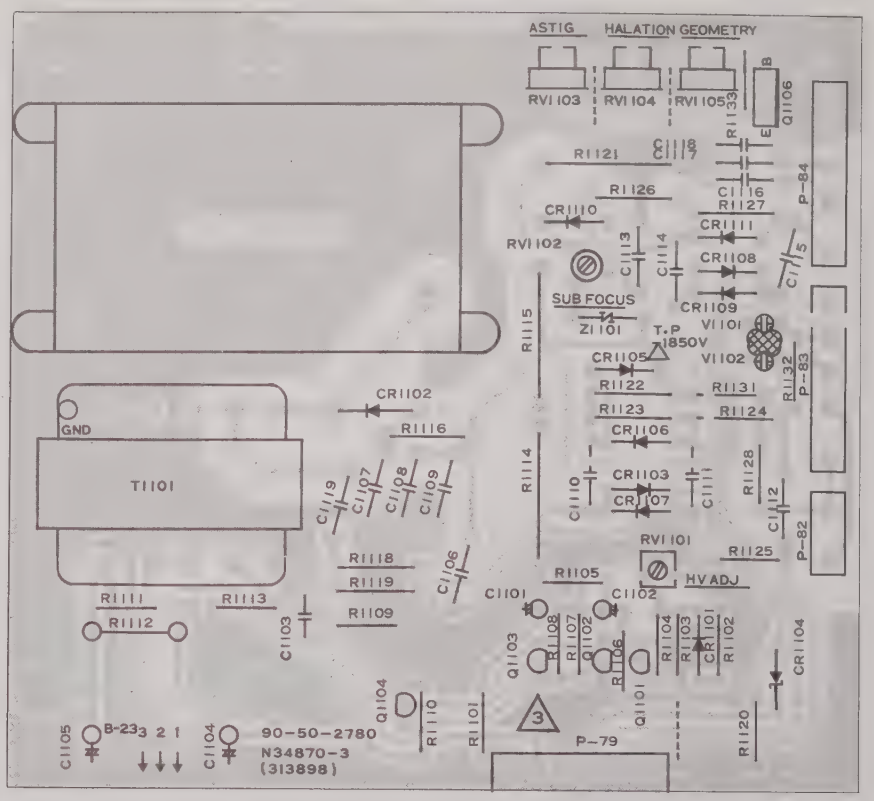
A7 A TRIG & A SWEEP Parts Location



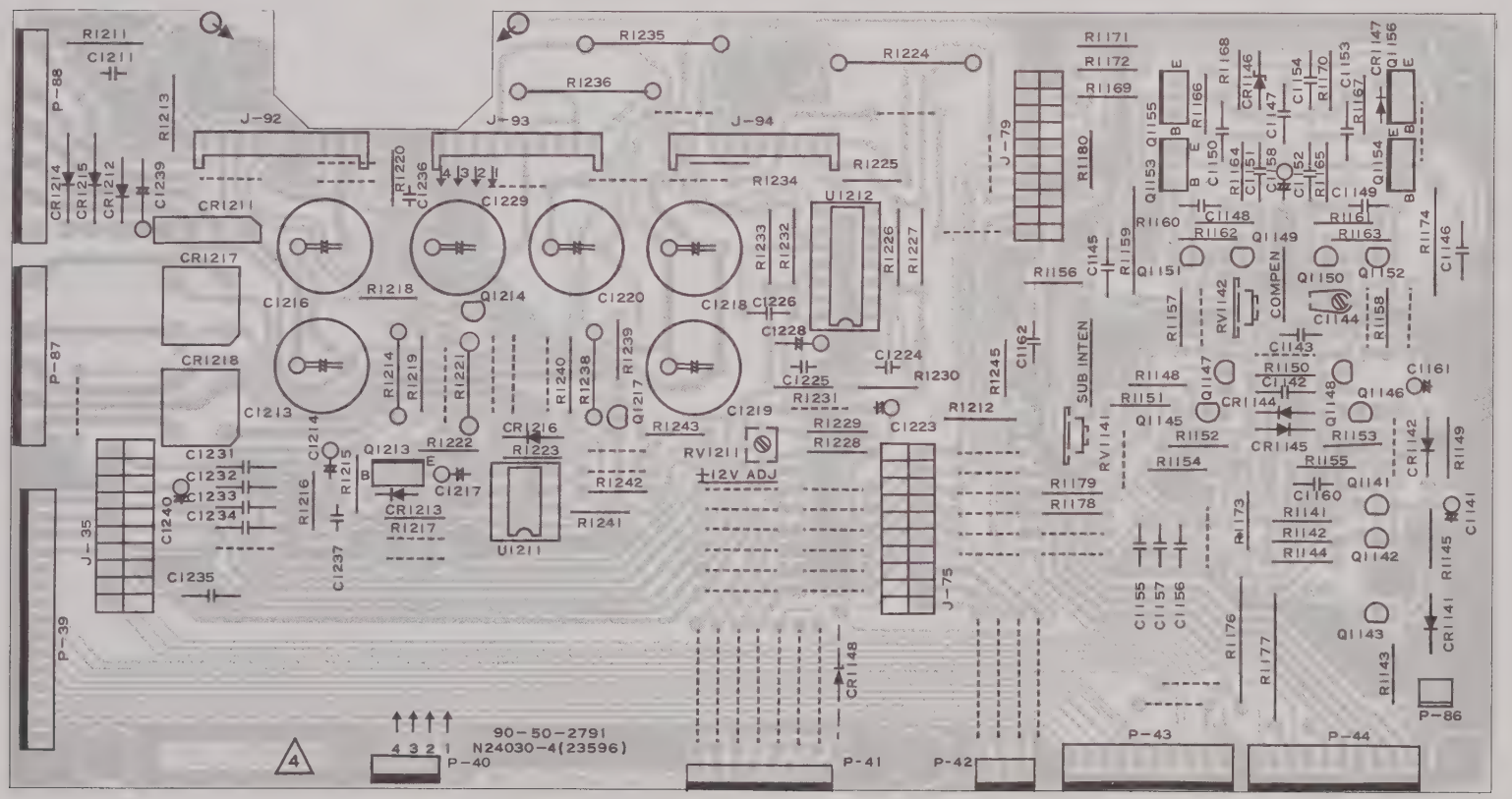
A8 B TRIG & B SWEEP Parts Location



A9 HORIZ OUTPUT AMP Parts Location



A10 H.V REGU. & CRT CIRCUIT Parts Location



A11 POWER SUPPLY & Z AMP Parts Location

ABBREVIATION

CER:	CERAMIC
C FILM:	CARBON FILM
C COMP:	CARBON COMPOSITION
CRT:	CATHODE RAY TUBE
ELECT:	ELECTROLYTIC
FET:	FIELD EFFECT TRANSISTOR
FXD:	FIXED
LED:	LIGHT EMITTING DIODE
M FILM:	METAL FILM
M GLAZE:	METAL GLAZE
M OX:	METAL OXIDE
M PLSTC FILM:	METALLIZED PLASTIC FILM
PLSTC FILM:	PLASTIC FILM
SI:	SILICON
TANT ELECT:	TANTALUM ELECTROLYTIC
VAR:	VARIABLE
WW:	WIREWOUND
*:	OPTIMUM VALUE SELECTED AT FACTORY. AVERAGE VALUE SHOWN (PART MAY BE OMITTED.)

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
A ASSEMBLY			
B ASSEMBLY			
C1201	52-77-1010	FXD CER 1000PF 250VAC	FOR UL & CSA
C1202	52-77-1010	FXD CER 1000PF 250VAC	FOR UL & CSA
CR311	37-00-0082	LAMP LED RED	TOSHIBA TLR102KW
CR710	37-00-0082	LAMP LED RED	TOSHIBA TLR102KW
CR711	37-00-0092	LAMP LED RED	TOSHIBA TLG102KW
CR810	37-00-0082	LAMP LED RED	TOSHIBA TLR102KW
CR1201	37-00-0061	LAMP LED GREEN	TOSHIBA TLG145
F1201	99-02-0002	FUSE 1A-250V S.B 5.2X20	
L1101	66-21-0050	ROTATION COIL	KIKUSUI S7901184
R501	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R611	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
RV108	46-20-3101	VAR M GLAZE 10K OHM B	
RV208	46-20-3101	VAR M GLAZE 10K OHM B	
RV403	46-20-3101	VAR M GLAZE 10K OHM B	
RV404	46-20-3101	VAR M GLAZE 10K OHM B	
RV705	49-26-3100	POTENTIOMETOR 10K OHM	
RV803	80-99-0060	SWITCH ROTARY TIME/DIV	
RV1001	45-02-0200	VAR C COMP 10K/10K OHM B	
RV1301	46-16-3101	VAR M GLAZE 10K OHM B	
V1101	21-46-0609	CATHODE RAY TUBE	150BWB31
A1 ASSEMBLY			
C101	50-96-3590	FXD PLSTC FILM 0.022UF 20% 630V	
C103	52-06-3145	FXD CER 22PF 10% 500V TYPE1	
C104	57-10-1180	VAR CER 1.5-4PF	
C105	57-10-1180	VAR CER 1.5-4PF	
C106	52-06-2165	FXD CER 33PF 10% 500V TYPE1	
C107	57-10-1180	VAR CER 1.5-4PF	
C108	57-10-1180	VAR CER 1.5-4PF	
C109	52-06-2225	FXD CER 100PF 10% 50V TYPE1	
C110	52-06-2225	FXD CER 100PF 10% 50V TYPE1	
C111	52-06-2215	FXD CER 82PF 10% 500V TYPE1	
C112	57-10-1180	VAR CER 1.5-4PF	
C113	57-10-1180	VAR CER 1.5-4PF	
C114	57-10-1180	VAR CER 1.5-4PF	
C115	57-10-1180	VAR CER 1.5-4PF	
C116	52-06-3030	FXD CER 3PF 10% 500V TYPE1	

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION COS6150
C117		50-87-0510	FXD PLSTC FILM 2200PF 20% 400V
C118		52-06-2125	FXD CER 15PF 10% 500V TYPE1
C119		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C120		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C122		52-06-2225	FXD CER 100PF 10% 50V TYPE1
C123		52-06-2265	FXD CER 220PF 10% 50V TYPE1
C124		55-37-2050	FXD TANT ELECT 1UF 35V
C125		50-67-0050	FXD PLSTC FILM 0.047UF 10% 100V
C126		57-10-1200	VAR CER 3.3-18PF
C127		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C128		52-06-3102	FXD CER 10PF 10% 500V TYPE1
C129		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C130		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C131		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C132		52-06-3155	FXD CER 27PF 10% 500V TYPE1
C133		52-06-3155	FXD CER 27PF 10% 500V TYPE1
C135		52-06-3125	FXD CER 15PF 10% 500V TYPE1
C136		54-00-0114	FXD ELECT 47UF 25V
C137		54-00-0311	FXD ELECT 10UF 50V
C138		54-00-0311	FXD ELECT 10UF 50V
C140		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C141		57-10-1203	VAR CER 5-20PF
C142		57-10-1230	VAR CER 3-10PF
C145		54-00-0311	FXD ELECT 10UF 50V
C146	*	52-06-3165	FXD CER 33PF 10% 500V TYPE1
C147		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C148		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C149		50-67-0030	FXD PLSTC FILM 0.01UF 10% 100V
C150		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C151		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C152		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C153		52-06-3102	FXD CER 10PF 10% 500V TYPE1
C154		52-06-3010	FXD CER 1PF 500V TYPE1
C155		52-06-2225	FXD CER 100PF 10% 50V TYPE1
C156		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C160		52-96-1140	FXD COMP 0.68PF 10% 500V
C163		52-06-3165	FXD CER 33PF 10% 500V TYPE1
C164		52-06-2225	FXD CER 100PF 10% 50V TYPE1
C166		52-06-3125	FXD CER 15PF 10% 500V TYPE1
C167		52-06-3125	FXD CER 15PF 10% 500V TYPE1
C169		52-06-2125	FXD CER 15PF 10% 500V TYPE1
C170		52-06-3030	FXD CER 3PF 10% 500V TYPE1
C174		52-06-2030	FXD CER 3P 10% 50V TYPE1
C175		52-06-2145	FXD CER 22PF 10% 500V TYPE1
C177		52-06-2225	FXD CER 100PF 10% 50V TYPE1
C178		52-06-2010	FXD CER 1PF 10% 50V TYPE1
C179		52-06-2051	FXD CER 5P 10% 50V TYPE1
C181		52-06-2102	FXD CER 10P 10% 50V TYPE1
C182		52-96-1140	FXD COMP 0.68PF 10% 500V
C183		52-06-2051	FXD CER 5P 10% 50V TYPE1
C201		50-96-3590	FXD PLSTC FILM 0.022UF 20% 630V
C203		52-06-3145	FXD CER 22PF 10% 500V TYPE1
C204		57-10-1180	VAR CER 1.5-4PF
C205		57-10-1180	VAR CER 1.5-4PF

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION COS6150
C206		52-06-2165	FXD CER 33PF 10% 500V TYPE1
C207		57-10-1180	VAR CER 1.5-4PF
C208		57-10-1180	VAR CER 1.5-4PF
C209		52-06-2225	FXD CER 100PF 10% 50V TYPE1
C210		52-06-2225	FXD CER 100PF 10% 50V TYPE1
C211		52-06-2215	FXD CER 82PF 10% 500V TYPE1
C212		57-10-1180	VAR CER 1.5-4PF
C213		57-10-1180	VAR CER 1.5-4PF
C214		57-10-1180	VAR CER 1.5-4PF
C215		57-10-1180	VAR CER 1.5-4PF
C216		52-06-3030	FXD CER 3PF 10% 500V TYPE1
C217		50-87-0510	FXD PLSTC FILM 2200PF 20% 400V
C218		52-06-2125	FXD CER 15PF 10% 500V TYPE1
C219		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C220		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C222		52-06-2225	FXD CER 100PF 10% 50V TYPE1
C223		52-06-2265	FXD CER 220PF 10% 50V TYPE1
C224		55-37-2050	FXD TANT ELECT 1UF 35V
C225		50-67-0050	FXD PLSTC FILM 0.047UF 10% 100V
C226		57-10-1200	VAR CER 3.3-18PF
C227		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C228		52-06-3102	FXD CER 10PF 10% 500V TYPE1
C229		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C230		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C231		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C232		52-06-3155	FXD CER 27PF 10% 500V TYPE1
C233		52-06-3155	FXD CER 27PF 10% 500V TYPE1
C235		52-06-3125	FXD CER 15PF 10% 500V TYPE1
C236		54-00-0114	FXD ELECT 47UF 25V
C237		54-00-0311	FXD ELECT 10UF 50V
C238		54-00-0311	FXD ELECT 10UF 50V
C240		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C241		57-10-1203	VAR CER 5-20PF
C242		57-10-1230	VAR CER 3-10PF
C246	*	52-06-3165	FXD CER 33PF 10% 500V TYPE1
C247		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C248		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C249		50-67-0030	FXD PLSTC FILM 0.01UF 10% 100V
C250		52-01-3345	FXD CER 1000PF 10% 500V TYPE2
C251		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C253		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C254		52-06-3010	FXD CER 1PF 500V TYPE1
C256		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C258		52-06-2030	FXD CER 3P 10% 50V TYPE1
C260		52-96-1140	FXD COMP 0.68PF 10% 500V
C263		52-06-3165	FXD CER 33PF 10% 500V TYPE1
C264		52-06-2225	FXD CER 100PF 10% 50V TYPE1
C266		52-06-3125	FXD CER 15PF 10% 500V TYPE1
C267		52-06-3125	FXD CER 15PF 10% 500V TYPE1
C268		52-06-2225	FXD CER 100PF 10% 50V TYPE1
C269		52-06-2125	FXD CER 15PF 10% 500V TYPE1
C270		52-06-3030	FXD CER 3PF 10% 500V TYPE1
C274		52-06-2030	FXD CER 3P 10% 50V TYPE1
C276		52-06-3165	FXD CER 33PF 10% 500V TYPE1

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS6150
C277		52-06-2225	FXD CER 100PF 10% 50V TYPE1	
C278		52-06-2010	FXD CER 1PF 10% 50V TYPE1	
C279		52-06-2051	FXD CER 5P 10% 50V TYPE1	
C280		52-06-2030	FXD CER 3P 10% 50V TYPE1	
C282		52-96-1140	FXD COMP 0.68PF 10% 500V	
C331		52-06-2184	FXD CER 47PF 10% 50V TYPE1	
C332		52-06-2245	FXD CER 150PF 10% 50V TYPE1	
C334		52-06-3125	FXD CER 15PF 10% 500V TYPE1	
C335		52-06-3125	FXD CER 15PF 10% 500V TYPE1	
C351		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C352		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C357		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C358		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C359		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C361		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C362		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C363		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C364		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C365		54-00-0311	FXD ELECT 10UF 50V	
C366		54-00-0311	FXD ELECT 10UF 50V	
C367		54-00-0311	FXD ELECT 10UF 50V	
C368		54-00-0311	FXD ELECT 10UF 50V	
C369		54-00-0311	FXD ELECT 10UF 50V	
C370		54-00-0311	FXD ELECT 10UF 50V	
C371		54-00-0311	FXD ELECT 10UF 50V	
C372		54-00-0311	FXD ELECT 10UF 50V	
C373		52-06-3030	FXD CER 3PF 10% 500V TYPE1	
C374		52-06-3030	FXD CER 3PF 10% 500V TYPE1	
C377		52-06-3145	FXD CER 22PF 10% 500V TYPE1	
C378		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C379		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C380		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C401		54-00-0311	FXD ELECT 10UF 50V	
C402		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C403		52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C404		54-00-0311	FXD ELECT 10UF 50V	
C405		52-06-2204	FXD CER 68P 10% 50V TYPE1	
C406		52-06-2204	FXD CER 68P 10% 50V TYPE1	
C407		57-10-1230	VAR CER 3-10PF	
C408		52-06-3165	FXD CER 33PF 10% 500V TYPE1	
C409		52-06-3165	FXD CER 33PF 10% 500V TYPE1	
C410		57-10-1203	VAR CER 5-20PF	
C411		56-48-1000	FXD CER EMI FILTER	
C412		56-48-1000	FXD CER EMI FILTER	
C413		56-48-1000	FXD CER EMI FILTER	
C414		52-06-2102	FXD CER 10P 10% 50V TYPE1	
C415	*	52-06-2102	FXD CER 10P 10% 50V TYPE1	
C416		52-06-3051	FXD CER 5PF 10% 500V TYPE1	
C417		52-06-3051	FXD CER 5PF 10% 500V TYPE1	
C418		52-06-3165	FXD CER 33PF 10% 500V TYPE1	
C419		52-06-3165	FXD CER 33PF 10% 500V TYPE1	
C424		54-00-0311	FXD ELECT 10UF 50V	
C425		52-06-2051	FXD CER 5P 10% 50V TYPE1	
CR101		37-00-0082	LAMP LED RED	TOSHIBA TLR102KW

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
CR102		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR103		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR104		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR105		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR106		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR201		37-00-0082	LAMP LED RED	TOSHIBA	TLR102KW
CR202		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR203		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR204		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR205		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR301		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR302		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR303		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR304		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR351		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR352		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR353		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR354		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR355		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR356		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR357		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR358		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR359		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR360		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR361		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR362		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR401		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR402		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR403		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR404		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR405		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR406		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR407		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR408		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR409		32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR410		32-99-0000	DIODE VAR,CAP	TOSHIBA	1SV101
CR411		32-99-0000	DIODE VAR,CAP	TOSHIBA	1SV101
CR412		32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
C143	*	52-06-3185	FXD CER 47PF 10% 500V TYPE1		
C353	*	52-06-3102	FXD CER 10PF 10% 500V TYPE1		
L101		67-10-0900	INDUCTOR 470UH 10%		
L201		67-10-0900	INDUCTOR 470UH 10%		
Q102		30-11-2061	TR SI PNP	NEC	2SA1206-L
Q103		30-11-2061	TR SI PNP	NEC	2SA1206-L
Q104		30-32-7532	TR SI NPN PAIR	TOSHIBA	S8402241
Q105		30-32-7532	TR SI NPN PAIR	TOSHIBA	S8402241
Q106		30-31-9071	TR SI NPN	HITACHI	2SC1907
Q107		30-31-9071	TR SI NPN	HITACHI	2SC1907
Q108		30-11-0051	TR SI PNP	NEC	2SA1005-L
Q109		30-31-9071	TR SI NPN	HITACHI	2SC1907
Q110		30-31-9071	TR SI NPN	HITACHI	2SC1907

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
Q111	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q112	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q113	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q114	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q115	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q202	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q203	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q204	30-32-7532	TR SI NPN PAIR	TOSHIBA	S8402241
Q205	30-32-7532	TR SI NPN PAIR	TOSHIBA	S8402241
Q209	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q210	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q211	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q212	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q213	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q214	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q308	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q309	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q310	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q311	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q351	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q352	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q353	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q354	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q355	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q401	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q402	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q403	30-11-2061	TR SI PNP	NEC	2SA1206-L
Q404	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q405	30-32-7532	TR SI NPN PAIR	TOSHIBA	S8402241
Q406	30-32-7532	TR SI NPN PAIR	TOSHIBA	S8402241
Q407	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q408	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q409	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q410	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q411	31-20-3041	FET PAIR 2SK304 5.0-12.0MA	SANYO	2SK304-F
QCR101	30-31-9071	TR SI NPN	HITACHI	2SC1907
QCR201	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q101-1	31-20-3042	FET PAIR 2SK304 30MA		S8407451
Q101-2	31-20-3042	FET PAIR 2SK304 30MA		S8407451
Q201-1	31-20-3042	FET PAIR 2SK304 30MA		S8407451
Q201-2	31-20-3042	FET PAIR 2SK304 30MA		S8407451
R101	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R102	40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R103	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R104	40-16-0560	FXD C FILM 56 OHM 5% 1/6W		
R105	42-73-4900	FXD M FILM 900K OHM 0.5% 1/2W		
R106	42-71-4111	FXD M FILM 111K OHM 0.5% 1/4W		
R107	40-16-1180	FXD C FILM 180 OHM 5% 1/6W		
R108	42-73-4990	FXD M FILM 990K OHM 0.5% 1/2W		
R109	42-71-3101	FXD M FILM 10.1K OHM 0.5% 1/4W		
R110	40-27-0152	FXD C FILM 15 OHM 5% 1/4W		

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R111		40-16-1180	FXD C FILM 180	OHM 5% 1/6W
R112		40-16-0680	FXD C FILM 68	OHM 5% 1/6W
R113		42-73-4600	FXD M FILM 600K	0.5% 1/2W
R114		42-73-4667	FXD M FILM 667K	0.5% 1/2W
R115		42-73-4800	FXD M FILM 800K	OHM 0.5% 1/2W
R116		42-71-4250	FXD M FILM 250K	OHM 0.5% 1/4W 100PPM/DEG
R117		42-73-5100	FXD M FILM 1M	OHM 0.5% 1/2W 100PPM/DEG
R118		40-37-4471	FXD C FILM 470K	OHM 5% 1/2W
R119		40-27-0682	FXD C FILM 68	OHM 5% 1/4W
R120		40-27-1152	FXD C FILM 150	OHM 5% 1/4W
R121		40-27-2102	FXD C FILM 1K	OHM 5% 1/4W
R122		42-72-1150	FXD M FILM 150	OHM 1% 1/4W
R123		40-16-0560	FXD C FILM 56	OHM 5% 1/6W
R124		42-72-3470	FXD M FILM 47K	OHM 1% 1/4W
R125		42-72-1330	FXD M FILM 330	OHM 1% 1/4W
R126		40-16-0100	FXD C FILM 10	OHM 5% 1/6W
R128		40-27-1332	FXD C FILM 330	OHM 5% 1/4W
R129		40-27-2392	FXD C FILM 3.9K	OHM 5% 1/4W
R130		40-27-2392	FXD C FILM 3.9K	OHM 5% 1/4W
R131		40-27-0472	FXD C FILM 47	OHM 5% 1/4W
R132		40-27-1272	FXD C FILM 270	OHM 5% 1/4W
R133		40-27-2392	FXD C FILM 3.9K	OHM 5% 1/4W
R134		40-27-0472	FXD C FILM 47	OHM 5% 1/4W
R135		40-27-2822	FXD C FILM 8.2K	OHM 5% 1/4W
R136		42-72-1150	FXD M FILM 150	OHM 1% 1/4W
R137		42-72-1150	FXD M FILM 150	OHM 1% 1/4W
R139		42-72-0820	FXD C FILM 82	OHM 1% 1/4W
R140		40-27-2182	FXD C FILM 1.8K	OHM 5% 1/4W
R141		40-27-1562	FXD C FILM 560	OHM 5% 1/4W
R142		40-27-3102	FXD C FILM 10K	OHM 5% 1/4W
R143		40-27-1562	FXD C FILM 560	OHM 5% 1/4W
R144		40-16-1120	FXD C FILM 120	OHM 5% 1/6W
R145		42-72-1560	FXD M FILM 560	OHM 1% 1/4W
R146		40-27-0332	FXD C FILM 33	OHM 5% 1/4W
R147		40-27-0222	FXD C FILM 22	OHM 5% 1/4W
R148		42-72-1560	FXD M FILM 560	OHM 1% 1/4W
R149		42-72-0330	FXD M FILM 33	OHM 1% 1/4W
R150		42-72-0330	FXD M FILM 33	OHM 1% 1/4W
R151		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R152		40-27-1472	FXD C FILM 470	OHM 5% 1/4W
R153		42-72-1150	FXD M FILM 150	OHM 1% 1/4W
R154		42-72-1150	FXD M FILM 150	OHM 1% 1/4W
R155		40-27-3472	FXD C FILM 47K	OHM 5% 1/4W
R156		40-27-1472	FXD C FILM 470	OHM 5% 1/4W
R157		40-16-0470	FXD C FILM 47	OHM 5% 1/6W
R158		42-72-2220	FXD M FILM 2.2K	OHM 1% 1/4W
R159		42-72-2220	FXD M FILM 2.2K	OHM 1% 1/4W
R160	*	42-72-2220	FXD M FILM 2.2K	OHM 1% 1/4W
R161		40-27-0472	FXD C FILM 47	OHM 5% 1/4W
R162		40-27-0472	FXD C FILM 47	OHM 5% 1/4W
R163		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R164		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R165		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R166		40-27-1102	FXD C FILM 100	OHM 5% 1/4W

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R167	40-27-2272	FXD C FILM	2.7K OHM 5% 1/4W
R168	40-27-2272	FXD C FILM	2.7K OHM 5% 1/4W
R169	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R170	40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W
R171	40-27-0222	FXD C FILM	22 OHM 5% 1/4W
R172	40-27-0222	FXD C FILM	22 OHM 5% 1/4W
R173	38-00-0070	THERMISTOR	200 OHM
R174	38-00-0051	THERMISTER	20 OHM TOSHIBA D-21A
R175	40-16-0100	FXD C FILM	10 OHM 5% 1/6W
R176	40-16-1330	FXD C FILM	330 OHM 5% 1/6W
R177	40-27-1182	FXD C FILM	180 OHM 5% 1/4W
R178	42-72-1270	FXD M FILM	270 OHM 1% 1/4W
R179	40-27-1392	FXD C FILM	390 OHM 5% 1/4W
R181	40-27-0562	FXD C FILM	56 OHM 5% 1/4W
R182	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R184	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R185	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R186	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R187	40-27-1822	FXD C FILM	820 OHM 5% 1/4W
R188	40-27-1822	FXD C FILM	820 OHM 5% 1/4W
R189	40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R190	40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R191	42-72-1560	FXD M FILM	560 OHM 1% 1/4W
R192	42-72-1560	FXD M FILM	560 OHM 1% 1/4W
R193	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R194	40-27-0332	FXD C FILM	33 OHM 5% 1/4W
R195	40-27-0332	FXD C FILM	33 OHM 5% 1/4W
R196	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R197	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R198	40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R199	40-27-2182	FXD C FILM	1.8K OHM 5% 1/4W
R201	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R202	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R203	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R204	40-16-0560	FXD C FILM	56 OHM 5% 1/6W
R205	42-73-4900	FXD M FILM	900K OHM 0.5% 1/2W
R206	42-71-4111	FXD M FILM	111K OHM 0.5% 1/4W
R207	40-16-1180	FXD C FILM	180 OHM 5% 1/6W
R208	42-73-4990	FXD M FILM	990K OHM 0.5% 1/2W
R209	42-71-3101	FXD M FILM	10.1K OHM 0.5% 1/4W
R210	40-27-0152	FXD C FILM	15 OHM 5% 1/4W
R211	40-16-1180	FXD C FILM	180 OHM 5% 1/6W
R212	40-16-0680	FXD C FILM	68 OHM 5% 1/6W
R213	42-73-4600	FXD M FILM	600K 0.5% 1/2W
R214	42-73-4667	FXD M FILM	667K 0.5% 1/2W
R215	42-73-4800	FXD M FILM	800K OHM 0.5% 1/2W
R216	42-71-4250	FXD M FILM	250K OHM 0.5% 1/4W 100PPM/DEG
R217	42-73-5100	FXD M FILM	1M OHM 0.5% 1/2W 100PPM/DEG
R218	40-37-4471	FXD C FILM	470K OHM 5% 1/2W
R219	40-27-0682	FXD C FILM	68 OHM 5% 1/4W
R220	40-27-1152	FXD C FILM	150 OHM 5% 1/4W
R221	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R222	42-72-1150	FXD M FILM	150 OHM 1% 1/4W
R223	40-16-0560	FXD C FILM	56 OHM 5% 1/6W

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R224		42-72-3470	FXD M FILM 47K	OHM 1% 1/4W
R225		42-72-1330	FXD M FILM 330	OHM 1% 1/4W
R226		40-16-0100	FXD C FILM 10	OHM 5% 1/6W
R228		40-27-1332	FXD C FILM 330	OHM 5% 1/4W
R229		40-27-2392	FXD C FILM 3.9K	OHM 5% 1/4W
R230		40-27-2392	FXD C FILM 3.9K	OHM 5% 1/4W
R231		40-27-0472	FXD C FILM 47	OHM 5% 1/4W
R232		40-27-1272	FXD C FILM 270	OHM 5% 1/4W
R233		40-27-2392	FXD C FILM 3.9K	OHM 5% 1/4W
R234		40-27-0472	FXD C FILM 47	OHM 5% 1/4W
R235		40-27-2822	FXD C FILM 8.2K	OHM 5% 1/4W
R236		42-72-1150	FXD M FILM 150	OHM 1% 1/4W
R237		42-72-1150	FXD M FILM 150	OHM 1% 1/4W
R239		42-72-0820	FXD C FILM 82	OHM 1% 1/4W
R240		40-27-2182	FXD C FILM 1.8K	OHM 5% 1/4W
R241		40-27-1562	FXD C FILM 560	OHM 5% 1/4W
R242		40-27-3102	FXD C FILM 10K	OHM 5% 1/4W
R243		40-27-1562	FXD C FILM 560	OHM 5% 1/4W
R244		40-16-1120	FXD C FILM 120	OHM 5% 1/6W
R245		42-72-1560	FXD M FILM 560	OHM 1% 1/4W
R246		40-27-0332	FXD C FILM 33	OHM 5% 1/4W
R247		40-27-0222	FXD C FILM 22	OHM 5% 1/4W
R248		42-72-1560	FXD M FILM 560	OHM 1% 1/4W
R249		42-72-0330	FXD M FILM 33	OHM 1% 1/4W
R250		42-72-0330	FXD M FILM 33	OHM 1% 1/4W
R251		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R252		40-27-1472	FXD C FILM 470	OHM 5% 1/4W
R253		42-72-1150	FXD M FILM 150	OHM 1% 1/4W
R254		42-72-1150	FXD M FILM 150	OHM 1% 1/4W
R255		40-27-3472	FXD C FILM 47K	OHM 5% 1/4W
R256		40-27-1472	FXD C FILM 470	OHM 5% 1/4W
R257		40-16-0470	FXD C FILM 47	OHM 5% 1/6W
R258		42-72-2220	FXD M FILM 2.2K	OHM 1% 1/4W
R259		42-72-2220	FXD M FILM 2.2K	OHM 1% 1/4W
R260	*	42-72-2220	FXD M FILM 2.2K	OHM 1% 1/4W
R261		40-27-0472	FXD C FILM 47	OHM 5% 1/4W
R262		40-27-0472	FXD C FILM 47	OHM 5% 1/4W
R263		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R264		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R265		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R266		40-27-1102	FXD C FILM 100	OHM 5% 1/4W
R267		40-27-2272	FXD C FILM 2.7K	OHM 5% 1/4W
R268		40-27-2272	FXD C FILM 2.7K	OHM 5% 1/4W
R269		40-27-0472	FXD C FILM 47	OHM 5% 1/4W
R270		40-27-2152	FXD C FILM 1.5K	OHM 5% 1/4W
R271		40-27-0222	FXD C FILM 22	OHM 5% 1/4W
R272		40-27-0222	FXD C FILM 22	OHM 5% 1/4W
R273		38-00-0070	THERMISTOR 200	OHM
R274		38-00-0051	THERMISTER 20	OHM TOSHIBA D-21A
R275		40-16-0100	FXD C FILM 10	OHM 5% 1/6W
R276		40-16-1330	FXD C FILM 330	OHM 5% 1/6W
R278		42-72-1270	FXD M FILM 270	OHM 1% 1/4W
R279		40-27-1392	FXD C FILM 390	OHM 5% 1/4W
R281		40-27-0562	FXD C FILM 56	OHM 5% 1/4W

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R282	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R284	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R285	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R286	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R287	40-27-1822	FXD C FILM	820 OHM 5% 1/4W
R288	40-27-1822	FXD C FILM	820 OHM 5% 1/4W
R289	40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R290	40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R291	42-72-1560	FXD M FILM	560 OHM 1% 1/4W
R292	42-72-1560	FXD M FILM	560 OHM 1% 1/4W
R293	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R294	40-27-0332	FXD C FILM	33 OHM 5% 1/4W
R295	40-27-0332	FXD C FILM	33 OHM 5% 1/4W
R296	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R297	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R298	40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R299	40-27-2182	FXD C FILM	1.8K OHM 5% 1/4W
R331	40-27-0332	FXD C FILM	33 OHM 5% 1/4W
R332	40-27-0682	FXD C FILM	68 OHM 5% 1/4W
R333	40-27-0682	FXD C FILM	68 OHM 5% 1/4W
R334	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R335	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R336	42-72-1560	FXD M FILM	560 OHM 1% 1/4W
R337	42-72-1560	FXD M FILM	560 OHM 1% 1/4W
R338	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R339	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R340	40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R341	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R342	40-27-2182	FXD C FILM	1.8K OHM 5% 1/4W
R343	40-27-2182	FXD C FILM	1.8K OHM 5% 1/4W
R344	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R345	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R346	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R347	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R348	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R351	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R352	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R353	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R354	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R355	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R356	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R357	42-72-1390	FXD M FILM	390 OHM 1% 1/4W
R358	40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W
R359	42-72-1390	FXD M FILM	390 OHM 1% 1/4W
R360	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R361	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R362	40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W
R363	40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W
R364	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R365	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R367	40-27-1122	FXD C FILM	120 OHM 5% 1/4W
R368	40-27-2272	FXD C FILM	2.7K OHM 5% 1/4W
R369	40-27-2272	FXD C FILM	2.7K OHM 5% 1/4W
R372	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R373	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R374	40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R375	40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R376	40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R377	40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R378	40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R379	40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R380	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R381	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R382	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R383	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R384	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R385	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R386	44-07-0020	FXD M GLAZE	RESISTOR NETWORKS - 10K OHM X4
R387	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R388	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R389	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R390	40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R391	40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R392	40-27-1152	FXD C FILM	150 OHM 5% 1/4W
R393	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R394	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R395	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R396	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R397	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R401	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R402	40-27-1182	FXD C FILM	180 OHM 5% 1/4W
R403	40-27-1182	FXD C FILM	180 OHM 5% 1/4W
R404	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R405	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R406	42-72-1270	FXD M FILM	270 OHM 1% 1/4W
R407	40-27-1822	FXD C FILM	820 OHM 5% 1/4W
R408	42-72-1270	FXD M FILM	270 OHM 1% 1/4W
R409	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R410	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R411	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R412	40-27-0562	FXD C FILM	56 OHM 5% 1/4W
R413	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R414	40-27-0562	FXD C FILM	56 OHM 5% 1/4W
R415	40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R416	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R417	40-27-0562	FXD C FILM	56 OHM 5% 1/4W
R418	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R419	40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W
R420	40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W
R421	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R422	42-71-1200	FXD M FILM	200 OHM 0.5% 1/4W
R423	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R424	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R425	40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R426	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R427	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R428	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R429	40-27-0472	FXD C FILM	47 OHM 5% 1/4W

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150		
R430	40-27-0472	FXD C FILM	47 OHM 5% 1/4W		
R431	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W		
R432	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W		
R433	40-27-1222	FXD C FILM	220 OHM 5% 1/4W		
R434	40-27-1222	FXD C FILM	220 OHM 5% 1/4W		
R435	40-27-0472	FXD C FILM	47 OHM 5% 1/4W		
R436	40-27-0472	FXD C FILM	47 OHM 5% 1/4W		
R437	40-27-1392	FXD C FILM	390 OHM 5% 1/4W		
R438	40-27-0222	FXD C FILM	22 OHM 5% 1/4W		
R439	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W		
R440	38-00-0080	THERMISTOR	2500 OHM		
R441	40-27-3472	FXD C FILM	47K OHM 5% 1/4W		
R442	40-27-3102	FXD C FILM	10K OHM 5% 1/4W		
R1401	40-27-4102	FXD C FILM	100K OHM 5% 1/4W		
R2171	40-27-0562	FXD C FILM	56 OHM 5% 1/4W		
R2172	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W		
R2173	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W		
R2174	42-72-1820	FXD M FILM	820 OHM 1% 1/4W		
R2175	40-27-0472	FXD C FILM	47 OHM 5% 1/4W		
R2176	40-27-1222	FXD C FILM	220 OHM 5% 1/4W		
R2177	40-27-2272	FXD C FILM	2.7K OHM 5% 1/4W		
R2178	40-27-0102	FXD C FILM	10 OHM 5% 1/4W		
R2179	40-27-0472	FXD C FILM	47 OHM 5% 1/4W		
R2180	40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W		
RV101	48-33-3200	VAR M FILM	20K OHM		
RV102	48-33-3200	VAR M FILM	20K OHM		
RV103	45-01-0540	VAR C COMP	500 OHM B		
RV104	48-33-3200	VAR M FILM	20K OHM		
RV105	48-33-2200	VAR M FILM	2K OHM		
RV106	48-33-1100	VAR M FILM	100 OHM		
RV107	48-33-2100	VAR M FILM	1K OHM		
RV109	48-33-2100	VAR M FILM	1K OHM		
RV110	48-33-2200	VAR M FILM	2K OHM		
RV201	48-33-3200	VAR M FILM	20K OHM		
RV202	48-33-3200	VAR M FILM	20K OHM		
RV203	45-01-0540	VAR C COMP	500 OHM B		
RV204	48-33-3200	VAR M FILM	20K OHM		
RV205	48-33-2200	VAR M FILM	2K OHM		
RV206	48-33-1100	VAR M FILM	100 OHM		
RV207	48-33-2100	VAR M FILM	1K OHM		
RV209	48-33-2100	VAR M FILM	1K OHM		
RV306	48-33-2100	VAR M FILM	1K OHM		
RV307	48-33-2100	VAR M FILM	1K OHM		
RV401	48-33-1100	VAR M FILM	100 OHM		
RV402	48-33-2100	VAR M FILM	1K OHM		
S101	82-70-8231	LEVER SWITCH		ALPS	SLR823-1
S102	80-98-0820	VERT ATT ROTARY SW		ALPS	
S201	82-70-8231	LEVER SWITCH		ALPS	SLR823-1
S202	80-98-0820	VERT ATT ROTARY SW		ALPS	
S311	82-70-8241	LEVER SWITCH		ALPS	SLR824-1
U101	30-90-0150	TRANSISTOR ARRAYS 5 NPN		RCA	CA3127E

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
U201	30-90-015C	TRANSISTOR ARRAYS 5 NPN	RCA CA3127E
U301	35-70-1581	QUAD 2-TO-1 DATA SELECTOR INV	TEXAS INS.SN74LS158N
U302	35-70-0081	QUAD 2-INPUT POSI-AND	TEXAS INS.SN74LS08N
U303	35-70-0041	HEX INVERTERS	TEXAS INS.SN74LS04N
U304	35-70-0081	QUAD 2-INPUT POSI-AND	TEXAS INS.SN74LS08N
U305	35-70-0421	BCD TO DECIMAL DECORDERS	TEXAS INS.SN74LS42N
A2 ASSEMBLY			
B3	84-38-0810	CONNECTOR P SIDE	
C301	50-96-3590	FXD PLSTC FILM 0.022UF 20% 630V	
C302	57-10-1190	VAR CER 3-10PF	
C303	57-10-1190	VAR CER 3-10PF	
C304	52-06-3145	FXD CER 22PF 10% 500V TYPE1	
C305	52-06-2145	FXD CER 22PF 10% 500V TYPE1	
C306	50-87-0510	FXD PLSTC FILM 2200PF 20% 400V	
C307	54-00-0311	FXD ELECT 10UF 50V	
C308	54-00-0311	FXD ELECT 10UF 50V	
C309	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C311	50-67-0060	FXD PLSTC FILM 0.1UF 10% 100V	
C312	50-67-0060	FXD PLSTC FILM 0.1UF 10% 100V	
C314	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C315	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C316	57-10-1190	VAR CER 3-10PF	
C317	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C318	52-06-2145	FXD CER 22PF 10% 500V TYPE1	
Q302	30-31-7301	TR SI NPN	NEC 2SC1730-L
Q303	30-31-7301	TR SI NPN	NEC 2SC1730-L
Q304	30-31-7301	TR SI NPN	NEC 2SC1730-L
Q305	30-31-7301	TR SI NPN	NEC 2SC1730-L
QCR301	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q301-1	31-20-3042	FET PAIR 2SK304 30MA	S8407451
Q301-2	31-20-3042	FET PAIR 2SK304 30MA	S8407451
R301	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R302	40-27-0000	JUMPER PARTS	
R303	42-73-4800	FXD M FILM 800K OHM 0.5% 1/2W	
R304	42-71-4250	FXD M FILM 250K OHM 0.5% 1/4W 100PPM/DEG	
R305	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R306	42-73-5100	FXD M FILM 1M OHM 0.5% 1/2W 100PPM/DEG	
R307	40-37-4471	FXD C FILM 470K OHM 5% 1/2W	
R308	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R309	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R311	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R312	40-27-2332	FXD C FILM 3.3K OHM 5% 1/4W	
R313	40-27-2332	FXD C FILM 3.3K OHM 5% 1/4W	
R314	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R317	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R318	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R319	40-27-1822	FXD C FILM 820 OHM 5% 1/4W	
R320	40-27-1822	FXD C FILM 820 OHM 5% 1/4W	
R321	40-27-1682	FXD C FILM 680 OHM 5% 1/4W	
R322	40-27-2332	FXD C FILM 3.3K OHM 5% 1/4W	
R323	40-27-2332	FXD C FILM 3.3K OHM 5% 1/4W	
R324	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R325	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R326	40-27-0222	FXD C FILM 22 OHM 5% 1/4W	
RV302	48-32-1500	VAR M GLAZE 500 OHM B PV	
RV303	48-32-1500	VAR M GLAZE 500 OHM B PV	
RV304	48-32-2100	VAR M GLAZE 1K OHM B PV	
R316 *	40-27-1392	FXD C FILM 390 OHM 5% 1/4W	
S301	81-03-0130	PUSH SWITCH	
A3 ASSEMBLY			
C381	52-01-3285	FXD CER 330PF 10% 500V TYPE1	
C382	52-01-3285	FXD CER 330PF 10% 500V TYPE1	
C383	54-00-0311	FXD ELECT 10UF 50V	
C384	54-00-0311	FXD ELECT 10UF 50V	
C385	54-00-0311	FXD ELECT 10UF 50V	
C386	54-00-0311	FXD ELECT 10UF 50V	
C387	52-06-3145	FXD CER 22PF 10% 500V TYPE1	
C388	54-00-0311	FXD ELECT 10UF 50V	
C389	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
CR363	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA 1S1588
Q356	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q357	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q358	30-30-9451	TR SI NPN	NEC 2SC945-Q
R1301	40-27-3122	FXD C FILM 12K OHM 5% 1/4W	
R1302	40-27-1822	FXD C FILM 820 OHM 5% 1/4W	
R1303	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W	
R1304	40-27-2102	FXD C FILM 1K OHM 5% 1/4W	
R1306	40-27-2102	FXD C FILM 1K OHM 5% 1/4W	
R1307	40-27-3102	FXD C FILM 10K OHM 5% 1/4W	
R1308	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W	
R1309	40-27-3102	FXD C FILM 10K OHM 5% 1/4W	
R1310	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R1311	40-27-1562	FXD C FILM 560 OHM 5% 1/4W	
R1312	40-27-1562	FXD C FILM 560 OHM 5% 1/4W	
R1313	40-27-1562	FXD C FILM 560 OHM 5% 1/4W	
R1314	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W	
R1315	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W	
R1316	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R1317	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
R1318	40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R1319	40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R1320	40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R1321	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R1340	44-08-0010	FXD M GLAZE RESISTOR NETWORKS	10K OHM X8	
S351	81-09-0000	PUSH SWITCH	ALPS SUE00	
U306	35-70-0001	QUAD 2-INPUT POSI-NAND	TEXAS INS.	SN74LS00N
U307	35-70-1121	DUAL J-K F-F WITH P/C	TEXAS INS.	SN74LS112N
U308	35-70-0001	QUAD 2-INPUT POSI-NAND	TEXAS INS.	SN74LS00N
U309	35-70-1121	DUAL J-K F-F WITH P/C	TEXAS INS.	SN74LS112N
U310	35-70-0001	QUAD 2-INPUT POSI-NAND	TEXAS INS.	SN74LS00N
A4 ASSEMBLY				
C441	52-06-3010	FXD CER 1PF 500V TYPE1		
C442	52-06-3010	FXD CER 1PF 500V TYPE1		
C443	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C444	52-06-3155	FXD CER 27PF 10% 500V TYPE1		
C445	57-10-1150	VAR CER 25-22.5PF		
C446	57-10-1150	VAR CER 25-22.5PF		
C447	57-10-1170	VAR CER 6-50PF		
C448	52-06-2184	FXD CER 47PF 10% 50V TYPE1		
C449	50-67-0040	FXD PLSTC FILM 0.022UF 10% 100V		
C450	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C451	52-06-3145	FXD CER 22PF 10% 500V TYPE1		
C452	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C453	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C454	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C455	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C456	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C457	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C458	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C459	54-00-0311	FXD ELECT 10UF 50V		
C462	52-06-2225	FXD CER 100PF 10% 50V TYPE1		
C463	52-01-3385	FXD CER 2220PF 10% 500V TYPE2		
C465	54-00-0311	FXD ELECT 10UF 50V		
C467	52-06-3145	FXD CER 22PF 10% 500V TYPE1		
C468	52-06-2265	FXD CER 220PF 10% 50V TYPE1		
C469	52-06-3051	FXD CER 5PF 10% 500V TYPE1		
CR441	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR442	32-92-0130	ZENER VZ 12.4-13.1V P 0.4W	NEC	RD13JB1
CR443	32-92-0130	ZENER VZ 12.4-13.1V P 0.4W	NEC	RD13JB1
CR444	32-92-0022	ZENER VZ 2.1 - 2.3V	HITACHI	HZ2B-3
CR445	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
DL441	91-90-0004	DELAY LINE 186 OHM		
L441	67-05-0000	INDUCTOR L-2868		
L442	67-05-0000	INDUCTOR L-2868		

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
L443	67-95-0020	INDUCTOR L-2874-2		
L444	67-95-0020	INDUCTOR L-2874-2		
Q441	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q442	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q443	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q444	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q445	30-32-7532	TR SI NPN PAIR	TOSHIBA	S8402241
Q446	30-32-7532	TR SI NPN PAIR	TOSHIBA	S8402241
Q447	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q448	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q449	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q450	30-32-0550	TR SI NPN	MITSUBISI	2SC2055
Q451	30-32-0550	TR SI NPN	MITSUBISI	2SC2055
Q452	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q453	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q454	30-31-1640	TR SI NPN	NEC	2SC1164
Q455	30-31-1640	TR SI NPN	NEC	2SC1164
Q456	30-32-1201	TR SI NPN	TOSHIBA	2SC2120-Y
R441	40-27-0912	FXD C FILM 91 OHM 5% 1/4W		
R442	40-27-0912	FXD C FILM 91 OHM 5% 1/4W		
R443	40-27-1332	FXD C FILM 330 OHM 5% 1/4W		
R444	40-27-1472	FXD C FILM 470 OHM 5% 1/4W		
R445	40-27-1472	FXD C FILM 470 OHM 5% 1/4W		
R446	40-27-2332	FXD C FILM 3.3K OHM 5% 1/4W		
R447	40-27-2332	FXD C FILM 3.3K OHM 5% 1/4W		
R448	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R449	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R450	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R451	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R452	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W		
R453	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W		
R454	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W		
R455	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W		
R456	40-27-2682	FXD C FILM 6.8K OHM 5% 1/4W		
R457	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W		
R458	42-72-1270	FXD M FILM 270 OHM 1% 1/4W		
R459	42-72-1270	FXD M FILM 270 OHM 1% 1/4W		
R460	40-27-1272	FXD C FILM 270 OHM 5% 1/4W		
R461	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W		
R462	40-27-1272	FXD C FILM 270 OHM 5% 1/4W		
R463	40-27-1152	FXD C FILM 150 OHM 5% 1/4W		
R464	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R465	40-27-0222	FXD C FILM 22 OHM 5% 1/4W		
R466	40-27-1562	FXD C FILM 560 OHM 5% 1/4W		
R467	40-27-1562	FXD C FILM 560 OHM 5% 1/4W		
R468	40-27-0222	FXD C FILM 22 OHM 5% 1/4W		
R469	40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R470	40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R471	40-27-0332	FXD C FILM 33 OHM 5% 1/4W		
R472	40-27-0332	FXD C FILM 33 OHM 5% 1/4W		
R473	40-27-1682	FXD C FILM 680 OHM 5% 1/4W		
R474	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W		

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R475	40-37-0331	FXD C FILM 33 OHM 5% 1/2W	
R476	40-27-1562	FXD C FILM 560 OHM 5% 1/4W	
R477	40-27-1562	FXD C FILM 560 OHM 5% 1/4W	
R478	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R479	40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W	
R480	40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W	
R481	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R482	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R483	40-27-1562	FXD C FILM 560 OHM 5% 1/4W	
R484	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R485	44-92-1220	FXD M OXIDE 220 OHM 5% 1W	
R486	44-92-1220	FXD M OXIDE 220 OHM 5% 1W	
R487	44-92-1220	FXD M OXIDE 220 OHM 5% 1W	
R488	44-92-1220	FXD M OXIDE 220 OHM 5% 1W	
R489	44-91-3220	FXD M OXIDE 22K OHM 5% 1W	
R490	44-91-3220	FXD M OXIDE 22K OHM 5% 1W	
R493	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R494	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R495	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R496	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R497	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R498	40-27-3102	FXD C FILM 10K OHM 5% 1/4W	
R499	40-27-1562	FXD C FILM 560 OHM 5% 1/4W	
R1441	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R1442	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R1443	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R1444	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
RV441	48-31-1100	VAR M GLAZE 100 OHM B PH	
RV442	48-31-2200	VAR M GLAZE 2K OHM B PH	
RV443	48-31-3200	FXD M GLAZE 20K OHM B PH	
RV444	48-31-3500	FXD M GLAZE 50K OHM B PH	
RV445	48-31-1100	VAR M GLAZE 100 OHM B PH	
RV446	48-31-3200	FXD M GLAZE 20K OHM B PH	
A5 ASSEMBLY			
C1181	50-45-0500	FXD PLSTC FILM 0.01MF 5% 50V	
C1182	50-45-0500	FXD PLSTC FILM 0.01MF 5% 50V	
C1184	52-06-3102	FXD CER 10PF 10% 500V TYPE1	
C1185	54-00-0311	FXD ELECT 10UF 50V	
C1187	52-06-2225	FXD CER 100PF 10% 50V TYPE1	
DS1201	23-35-0020	LAMP FILAMENT 6.3V 150MA	
DS1202	23-35-0020	LAMP FILAMENT 6.3V 150MA	
DS1203	23-35-0020	LAMP FILAMENT 6.3V 150MA	
Q1201	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q1202	30-11-0151	TR SI PNP	TOSHIBA 2SA1015-Y
R1181 *	40-27-3472	FXD C FILM 47K OHM 5% 1/4W	
R1182	40-27-4102	FXD C FILM 100K OHM 5% 1/4W	

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R1183	40-27-3102	FXD C FILM 10K OHM 5% 1/4W	
R1184	40-27-3102	FXD C FILM 10K OHM 5% 1/4W	
R1185	40-27-4102	FXD C FILM 100K OHM 5% 1/4W	
R1186	40-27-3102	FXD C FILM 10K OHM 5% 1/4W	
R1187	40-27-3122	FXD C FILM 12K OHM 5% 1/4W	
R1189	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W	
R1190	42-72-2910	FXD M FILM 9.1K OHM 1% 1/4W	
R1191	42-72-2180	FXD M FILM 1.8K OHM 1% 1/4W	
R1192	42-71-1200	FXD M FILM 200 OHM 0.5% 1/4W	
R1193	40-27-0102	FXD C FILM 10 OHM 5% 1/4W	
R1201	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W	
R1202	40-27-3102	FXD C FILM 10K OHM 5% 1/4W	
R1203	40-27-2102	FXD C FILM 1K OHM 5% 1/4W	
R1204	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W	
RV1181	48-32-4100	VAR M GLAZE 100K OHM B	
RV1182	48-32-2200	VAR M GLAZE 2K OHM B	
RV1202	46-16-3102	VAR M GLAZE 10K OHM B	
RV1203	46-16-4102	VAR M GLAZE 100K OHM B	
RV1204	46-16-2502	VAR M GLAZE 5K OHM B	
RV1205	46-16-2502	VAR M GLAZE 5K OHM B	
S1201	81-01-0270	PUSH SWITCH	ALPS SDG5P-E
U1101	35-60-0002	QUAD 2-INPUT NAND GATES	TOSHIBA TC4011BP

A6 ASSEMBLY

C571	55-37-2050	FXD TANT ELECT 1UF 35V	
C572	50-67-0050	FXD PLSTC FILM 0.047UF 10% 100V	
C573	55-37-2000	FXD TANT ELECT 0.1MF 35V	
C574	52-06-3145	FXD CER 22PF 10% 500V TYPE1	
C575	54-00-0311	FXD ELECT 10UF 50V	
C576	54-00-0311	FXD ELECT 10UF 50V	
C681	54-00-0311	FXD ELECT 10UF 50V	
C682	52-06-2010	FXD CER 1PF 10% 50V TYPE1	
C701	55-37-2050	FXD TANT ELECT 1UF 35V	
C702	54-00-0311	FXD ELECT 10UF 50V	
C703	55-37-2050	FXD TANT ELECT 1UF 35V	
C704	54-00-0311	FXD ELECT 10UF 50V	
C705	55-37-2050	FXD TANT ELECT 1UF 35V	
C706	54-00-0311	FXD ELECT 10UF 50V	
C708	52-06-3030	FXD CER 3PF 10% 500V TYPE1	
C709	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C710	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C711	52-06-2204	FXD CER 68P 10% 50V TYPE1	
C713	52-06-2204	FXD CER 68P 10% 50V TYPE1	
C715	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C716	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C717	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C718	54-00-0311	FXD ELECT 10UF 50V	
C720	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2	

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
C721	54-00-0311	FXD ELECT 10UF 50V		
C722	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C723	54-00-0311	FXD ELECT 10UF 50V		
C724	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C771	54-00-0311	FXD ELECT 10UF 50V		
C772	54-00-0311	FXD ELECT 10UF 50V		
C773	55-37-2050	FXD TANT ELECT 1UF 35V		
C775	55-37-2050	FXD TANT ELECT 1UF 35V		
C1001	54-00-0114	FXD ELECT 47UF 25V		
C1002	54-00-0114	FXD ELECT 47UF 25V		
C1003	52-06-3185	FXD CER 47PF 10% 500V TYPE1		
C1005	54-00-0114	FXD ELECT 47UF 25V		
C1007	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1008	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1009	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1011	52-06-2225	FXD CER 100PF 10% 50V TYPE1		
C1012	54-00-0311	FXD ELECT 10UF 50V		
C1013	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1014	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C1015	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C1016	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
CR571	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR681	32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR702	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR703	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR704	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR705	32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR706	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR707	32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR709	32-30-0860	DIODE VR 30V IO 30MA	HITACHI	1SS86
CR712	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR713	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR714	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR715	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1001	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1002	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1003	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1005	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1006	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
Q571	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q572	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q573	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q701	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q702	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q703	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q704	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q705	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q706	31-90-0080	FET DUAL	NEC	UPA68H-M
Q707	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q1001	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q1002	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q1003	30-10-8441	TR SI PNP	HITACHI	2SA844-D

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
Q1004	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q1005	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q1006	30-11-0151	TR SI PNP	TOSHIBA	2SA1015-Y
Q1007	30-11-0151	TR SI PNP	TOSHIBA	2SA1015-Y
Q1008	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q1009	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q1010	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q1011	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q1012	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q1013	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q1014	30-30-9451	TR SI NPN	NEC	2SC945-Q
R571	40-27-5102	FXD C FILM 1M OHM 5% 1/4W		
R572	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R573	40-27-1562	FXD C FILM 560 OHM 5% 1/4W		
R574	40-27-1562	FXD C FILM 560 OHM 5% 1/4W		
R575	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W		
R576	40-27-1472	FXD C FILM 470 OHM 5% 1/4W		
R577	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R578	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R579	40-27-1472	FXD C FILM 470 OHM 5% 1/4W		
R580	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R581	40-27-1472	FXD C FILM 470 OHM 5% 1/4W		
R582	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R584	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R585	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R586	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R587	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W		
R588	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R589	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R590	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W		
R591	40-27-8472	FXD C FILM 4.7 OHM 5% 1/4W		
R592	40-27-8472	FXD C FILM 4.7 OHM 5% 1/4W		
R593	40-27-8472	FXD C FILM 4.7 OHM 5% 1/4W		
R681	40-27-1472	FXD C FILM 470 OHM 5% 1/4W		
R682	40-27-1472	FXD C FILM 470 OHM 5% 1/4W		
R683	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R684	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R685	40-27-8472	FXD C FILM 4.7 OHM 5% 1/4W		
R686	40-16-1331	FXD C FILM 330 OHM 5% 1/6W		
R701	40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R702	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R703	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W		
R704	40-27-1682	FXD C FILM 680 OHM 5% 1/4W		
R705	40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R706	40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R707	40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R708	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R709	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R710	40-27-1472	FXD C FILM 470 OHM 5% 1/4W		
R711	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R712	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R713	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R714	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R715	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R716	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R717	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R718	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R719	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R720	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R721	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R722	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R723	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R724	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R725	40-27-1472	FXD C FILM	470 OHM 5% 1/4W
R726	40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R727	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R728	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R729	40-27-1472	FXD C FILM	470 OHM 5% 1/4W
R730	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R731	40-27-2182	FXD C FILM	1.8K OHM 5% 1/4W
R732	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R734	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R735	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R736	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R737	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R738	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R739	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R740	40-27-1472	FXD C FILM	470 OHM 5% 1/4W
R742	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R743	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R744	40-27-2182	FXD C FILM	1.8K OHM 5% 1/4W
R746	40-27-1472	FXD C FILM	470 OHM 5% 1/4W
R747	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R748	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R749	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R750	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R751	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R752	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R754	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R755	40-27-8472	FXD C FILM	4.7 OHM 5% 1/4W
R756	40-27-8472	FXD C FILM	4.7 OHM 5% 1/4W
R757	40-27-8472	FXD C FILM	4.7 OHM 5% 1/4W
R758	40-27-1272	FXD C FILM	270 OHM 5% 1/4W
R759	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R760	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R771	40-27-2182	FXD C FILM	1.8K OHM 5% 1/4W
R772	40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W
R773	42-72-2220	FXD M FILM	2.2K OHM 1% 1/4W
R774	42-72-3100	FXD M FILM	10K OHM 1% 1/4W
R775	42-72-2560	FXD M FILM	5.6K OHM 1% 1/4W
R776	42-72-1220	FXD M FILM	220 OHM 1% 1/4W
R777	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R778	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R779	40-37-3221	FXD C FILM	22K OHM 5% 1/2W
R780	40-37-3101	FXD C FILM	10K OHM 5% 1/2W
R781	40-37-3221	FXD C FILM	22K OHM 5% 1/2W
R782	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W

REFERENCE DESIGNATOR		KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R783		40-27-1562	FXD C FILM	560 OHM 5% 1/4W
R784		40-27-3562	FXD C FILM	56K OHM 5% 1/4W
R785		40-27-1472	FXD C FILM	470 OHM 5% 1/4W
R786		40-27-1332	FXD C FILM	330 OHM 5% 1/4W
R787		40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R788		40-27-2272	FXD C FILM	2.7K OHM 5% 1/4W
R1001		42-72-2180	FXD M FILM	1.8K OHM 1% 1/4W
R1002		42-72-2180	FXD M FILM	1.8K OHM 1% 1/4W
R1003		42-72-2180	FXD M FILM	1.8K OHM 1% 1/4W
R1004		42-72-2180	FXD M FILM	1.8K OHM 1% 1/4W
R1005		40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R1006		40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R1007		40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R1008		40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R1009		40-27-1332	FXD C FILM	330 OHM 5% 1/4W
R1010		40-27-1152	FXD C FILM	150 OHM 5% 1/4W
R1011		40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R1012		40-27-1682	FXD C FILM	680 OHM 5% 1/4W
R1013		40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R1014		40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R1015		40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R1017		40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R1018		42-72-2330	FXD M FILM	3.3K OHM 1% 1/4W
R1019		42-72-1390	FXD M FILM	390 OHM 1% 1/4W
R1020		40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W
R1021		40-27-3272	FXD C FILM	27K OHM 5% 1/4W
R1022		42-72-1390	FXD M FILM	390 OHM 1% 1/4W
R1023		42-72-2390	FXD M FILM	3.9K OHM 1% 1/4W
R1024		42-72-2390	FXD M FILM	3.9K OHM 1% 1/4W
R1025		42-72-2390	FXD M FILM	3.9K OHM 1% 1/4W
R1026		40-27-2122	FXD C FILM	1.2K OHM 5% 1/4W
R1027		42-72-2390	FXD M FILM	3.9K OHM 1% 1/4W
R1028		40-27-1822	FXD C FILM	820 OHM 5% 1/4W
R1029		42-72-2100	FXD M FILM	1K OHM 1% 1/4W
R1030		40-27-1822	FXD C FILM	820 OHM 5% 1/4W
R1031		42-72-2100	FXD M FILM	1K OHM 1% 1/4W
R1032		40-27-1332	FXD C FILM	330 OHM 5% 1/4W
R1033		40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R1034	*	40-27-2152	FXD C FILM	1.5K OHM 5% 1/4W
R1035	*	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R1036		40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W
R1037		40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R1038		40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R1039		40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R1040		40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R1041		40-27-0472	FXD C FILM	47 OHM 5% 1/4W
R1042		40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R1043		40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R1044		40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R1045		40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
RV701		48-32-2100	VAR M GLAZE	1K OHM B PV
RV702		48-32-2100	VAR M GLAZE	1K OHM B PV
RV703		48-29-2200	VAR M GLAZE	2K OHM

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
RV704	48-29-3100	VAR M GLAZE 10K OHM		
RV1003	48-32-2100	VAR M GLAZE 1K OHM B PV		
RV1004	48-32-2100	VAR M GLAZE 1K OHM B PV		
RV1005	48-32-1100	VAR M GLAZE 100 OHM B PV		
S1001	81-04-0250	PUSH SWITCH	ALPS	SUE40
U504	35-29-0001	TRIPLE LINE RECEIVER	MOTOROLA	MC10H116
U505	35-20-0001	QUAD 2INPUT NOR	MOTOROLA	MC10H102
U604	35-29-0001	TRIPLE LINE RECEIVER	MOTOROLA	MC10H116
U701	35-70-1231	DUAL RETRIGGER MONO-MULTI	TEXAS INS.	SN74LS123N
U702	35-70-1231	DUAL RETRIGGER MONO-MULTI	TEXAS INS.	SN74LS123N
U703	34-69-0010	QUAD BILATERAL SWITCH	TOSHIBA	TC4066BP
U704	35-23-0001	DUAL D-FLIP FLOP	MOTOROLA	MC10H131
U705	35-20-0000	QUAD 2-INPUT NOR	HITACHI	HD10102
U706	35-29-0000	TRIPLE LINE RECEIVER	HITACHI	HD10116
U707	35-23-0001	DUAL D-FLIP FLOP	MOTOROLA	MC10H131
U708	35-20-0000	QUAD 2-INPUT NOR	HITACHI	HD10102
U709	34-00-0215	J-FET INPUT OPE-AMP	TEXAS INS.	TL081CP
U1001	35-70-0001	QUAD 2-INPUT POSI-NAND	TEXAS INS.	SN74LS00N
U1002	35-70-0741	DUAL D F-F EDGE TRIGGER	TEXAS INS.	HD74LS74P

A7 ASSEMBLY

C501	57-10-1190	VAR CER 3-10PF
C502	57-10-1190	VAR CER 3-10PF
C503	52-06-3145	FXD CER 22PF 10% 500V TYPE1
C504	50-67-0040	FXD PLSTC FILM 0.022UF 10% 100V
C505	52-06-3185	FXD CER 47PF 10% 500V TYPE1
C506	52-01-3385	FXD CER 2220PF 10% 500V TYPE2
C507	54-00-0311	FXD ELECT 10UF 50V
C508	54-00-0311	FXD ELECT 10UF 50V
C509	52-06-3125	FXD CER 15PF 10% 500V TYPE1
C511	55-37-2050	FXD TANT ELECT 1UF 35V
C512	55-37-2050	FXD TANT ELECT 1UF 35V
C513	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C514	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C515	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C516	54-00-0311	FXD ELECT 10UF 50V
C517	52-06-3165	FXD CER 33PF 10% 500V TYPE1
C518	52-06-3165	FXD CER 33PF 10% 500V TYPE1
C521	56-48-1000	FXD CER EMI FILTER
C522	56-48-1000	FXD CER EMI FILTER
C523	56-48-1000	FXD CER EMI FILTER
C524	50-67-0040	FXD PLSTC FILM 0.022UF 10% 100V
C582	57-10-1180	VAR CER 1.5-4PF
C583	52-06-2030	FXD CER 3P 10% 50V TYPE1
C585	52-06-3185	FXD CER 47PF 10% 500V TYPE1
C801	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C804	54-00-0301	FXD ELECT 1UF 50V
C805	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C806	52-06-2265	FXD CER 220PF 10% 50V TYPE1

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
C807	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C808	52-01-2265	FXD CER 220PF 10% 50V TYPE2		
C811	50-65-3550	FXD PLSTC FILM 1MF 5% 200V		
C812	50-45-1500	FXD PLSTC FILM 0.01MF 5% 50V		
C813	52-06-2215	FXD CER 82PF 10% 500V TYPE1		
C814	57-10-1150	VAR CER 25-22.5PF		
C816	54-00-0311	FXD ELECT 10UF 50V		
C817	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C819	54-00-0114	FXD ELECT 47UF 25V		
C820	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
CR502	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR503	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR504	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR505	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR801	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR802	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR803	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR804	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR805	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR806	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR807	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR808	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR809	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR811	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR812	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR813	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR814	32-92-0033	ZENER VZ 3.2 - 3.4V	HITACHI	HZ3C-2
Q502	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q503	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q504	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q505	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q506	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q507	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q508	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q581	30-31-7301	TR SI NPN	NEC	2SC1730-L
Q582	30-31-7301	TR SI NPN	NEC	2SC1730-L
Q801	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q802	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q803	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q804	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q805	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q806	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q807	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q808	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q809	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q810	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q811	31-20-1073	FET IDSS 4.5-7.7MA	SONY	2SK107-3
Q812	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q813	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q814	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q815	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q816	30-10-8441	TR SI PNP	HITACHI	2SA844-D

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
Q817	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q818	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q819	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q820	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q821	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q822	30-10-8441	TR SI PNP	HITACHI	2SA844-D
QCR501	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q501-1	31-20-3042	FET PAIR 2SK304 30MA		S8407451
Q501-2	31-20-3042	FET PAIR 2SK304 30MA		S8407451
R502	40-27-0562	FXD C FILM 56 OHM 5% 1/4W		
R503	42-73-4800	FXD M FILM 800K OHM 0.5% 1/2W		
R504	42-71-4250	FXD M FILM 250K OHM 0.5% 1/4W 100PPM/DEG		
R505	40-27-3472	FXD C FILM 47K OHM 5% 1/4W		
R506	42-73-5100	FXD M FILM 1M OHM 0.5% 1/2W 100PPM/DEG		
R507	40-27-4472	FXD C FILM 470K OHM 5% 1/4W		
R508	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R509	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R510	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R511	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R512	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W		
R513	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W		
R514	40-27-1472	FXD C FILM 470 OHM 5% 1/4W		
R515	40-27-2682	FXD C FILM 6.8K OHM 5% 1/4W		
R516	40-27-1682	FXD C FILM 680 OHM 5% 1/4W		
R520	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R521	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R522	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R523	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R524	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R525	40-27-1332	FXD C FILM 330 OHM 5% 1/4W		
R526	40-27-1332	FXD C FILM 330 OHM 5% 1/4W		
R527	40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R528	40-27-4102	FXD C FILM 100K OHM 5% 1/4W		
R529	40-27-5102	FXD C FILM 1M OHM 5% 1/4W		
R530	40-27-5102	FXD C FILM 1M OHM 5% 1/4W		
R531	40-27-5102	FXD C FILM 1M OHM 5% 1/4W		
R532	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R533	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R534	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R535	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R536	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R537	40-27-1182	FXD C FILM 180 OHM 5% 1/4W		
R538	40-27-1182	FXD C FILM 180 OHM 5% 1/4W		
R539	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R540	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R541	40-27-0562	FXD C FILM 56 OHM 5% 1/4W		
R542	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R543	40-27-0562	FXD C FILM 56 OHM 5% 1/4W		
R544	40-27-3102	FXD C FILM 10K OHM 5% 1/4W		
R551	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R552	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R553	40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W
R555	40-27-1392	FXD C FILM	390 OHM 5% 1/4W
R556	40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W
R558	42-72-1680	FXD M FILM	680 OHM 1% 1/4W
R559	42-72-1680	FXD M FILM	680 OHM 1% 1/4W
R561	40-27-0222	FXD C FILM	22 OHM 5% 1/4W
R562	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R563	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R802	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R803	40-27-3332	FXD C FILM	33K OHM 5% 1/4W
R804	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R805	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R806	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R807	40-27-8472	FXD C FILM	4.7 OHM 5% 1/4W
R808	40-27-0222	FXD C FILM	22 OHM 5% 1/4W
R809	40-27-1392	FXD C FILM	390 OHM 5% 1/4W
R810	40-27-3102	FXD C FILM	10K OHM 5% 1/4W
R811	40-27-2222	FXD C FILM	2.2K OHM 5% 1/4W
R812	40-27-2182	FXD C FILM	1.8K OHM 5% 1/4W
R813	40-27-2272	FXD C FILM	2.7K OHM 5% 1/4W
R814	40-37-3391	FXD C FILM	39K OHM 5% 1/2W
R815	40-27-4472	FXD C FILM	470K OHM 5% 1/4W
R816	40-27-4472	FXD C FILM	470K OHM 5% 1/4W
R817	40-27-2272	FXD C FILM	2.7K OHM 5% 1/4W
R818	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R819	40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W
R820	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R821	40-27-1152	FXD C FILM	150 OHM 5% 1/4W
R822	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R823	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R824	42-72-2560	FXD M FILM	5.6K OHM 1% 1/4W
R825	42-72-2560	FXD M FILM	5.6K OHM 1% 1/4W
R826	42-72-3100	FXD M FILM	10K OHM 1% 1/4W
R827	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R828	42-71-3500	FXD M FILM	50K OHM 0.5% 1/4W
R829	42-71-3200	FXD M FILM	20K OHM 0.5% 1/4W
R830	42-71-3100	FXD M FILM	10K OHM 0.5% 1/4W
R831	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R832	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R833	42-73-5100	FXD M FILM	1M OHM 0.5% 1/2W 100PPM/DEG
R834	42-71-4100	FXD M FILM	100K OHM 0.5% 1/4W
R835	42-71-3100	FXD M FILM	10K OHM 0.5% 1/4W
R836	42-71-1990	FXD M FILM	990 OHM 0.5% 1/4W
R837	42-72-2107	FXD M FILM	1.07K OHM 1% 1/4W
R838	40-27-2472	FXD C FILM	4.7K OHM 5% 1/4W
R839	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R840	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R841	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R842	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R843	40-27-3222	FXD C FILM	22K OHM 5% 1/4W
R844	40-27-3222	FXD C FILM	22K OHM 5% 1/4W
R845	40-27-3222	FXD C FILM	22K OHM 5% 1/4W
R846	40-27-3122	FXD C FILM	12K OHM 5% 1/4W
R847	44-07-0110	FXD M GLAZE	RESISTOR NETWORKS 100K OHM X10

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
R848	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W		
R851	40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R852	40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R853	40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R855	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R856	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W		
R857	40-27-0822	FXD C FILM 82 OHM 5% 1/4W		
RV501	45-01-0560	VAR C COMP 10K/100K OHM B		
RV503	48-32-1500	VAR M GLAZE 500 OHM B PV		
RV801	48-30-3100	VAR M GLAZE 10K OHM		
RV802	48-30-3100	VAR M GLAZE 10K OHM		
S501	82-70-5242	LEVER SWITCH	ALPS	SLR524-2
S502	82-70-5242	LEVER SWITCH	ALPS	SLR524-2
S505	82-70-5222	PUSH SWITCH	ALPS	SLR522-2
U501	30-90-0150	TRANSISTOR ARRAYS 5 NPN	RCA	CA3127E
U502	34-00-0215	J-FET INPUT OPE-AMP	TEXAS INS.	TL081CP
U503	30-90-0141	TRANSISTOR ARRAYS 5 NPN	RCA	CA3086
U801	34-00-0215	J-FET INPUT OPE-AMP	TEXAS INS.	TL081CP
U802	34-69-0010	QUAD BILATERAL SWITCH	TOSHIBA	TC4066BP
U803	35-60-0080	HEX INV BUFFER/CONV	TOSHIBA	TC4009UBP
U804	35-60-0100	TRIPLE 3-INPUT NAND GATE	TOSHIBA	TC4023BP
U805	35-60-0040	QUAD EXCLUSIVE OR	TOSHIBA	TC4030BP

A8 ASSEMBLY

C611	57-10-1190	VAR CER 3-10PF
C612	57-10-1190	VAR CER 3-10PF
C613	52-06-3165	FXD CER 33PF 10% 500V TYPE1
C614	50-67-0040	FXD PLSTC FILM 0.022UF 10% 100V
C615	52-06-3185	FXD CER 47PF 10% 500V TYPE1
C616	52-06-3185	FXD CER 47PF 10% 500V TYPE1
C617	52-01-3385	FXD CER 2220PF 10% 500V TYPE2
C618	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C619	54-00-0311	FXD ELECT 10UF 50V
C620	54-00-0311	FXD ELECT 10UF 50V
C621	52-06-3125	FXD CER 15PF 10% 500V TYPE1
C623	55-37-2050	FXD TANT ELECT 1UF 35V
C624	55-37-2050	FXD TANT ELECT 1UF 35V
C625	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C626	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C627	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2
C628	54-00-0311	FXD ELECT 10UF 50V
C629	52-06-3165	FXD CER 33PF 10% 500V TYPE1
C630	52-06-3165	FXD CER 33PF 10% 500V TYPE1
C662	57-10-1180	VAR CER 1.5-4PF
C665	52-06-2184	FXD CER 47PF 10% 50V TYPE1
C667	54-00-0311	FXD ELECT 10UF 50V
C668	54-00-0311	FXD ELECT 10UF 50V
C669	56-48-1000	FXD CER EMI FILTER

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION COS6150		
C670	56-48-1000	FXD CER EMI FILTER		
C671	56-48-1000	FXD CER EMI FILTER		
C901	50-65-3550	FXD PLSTC FILM 1MF 5% 200V		
C902	50-45-1500	FXD PLSTC FILM 0.01MF 5% 50V		
C903	52-06-2215	FXD CER 82PF 10% 500V TYPE1		
C904	57-10-1150	VAR CER 25-22.5PF		
C905	54-00-0311	FXD ELECT 10UF 50V		
C906	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C908	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C909	54-00-0114	FXD ELECT 47UF 25V		
C910	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C911	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C912	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C913	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C914	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
CR901	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR902	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR903	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR904	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR905	32-92-0033	ZENER VZ 3.2 - 3.4V	HITACHI	HZ3C-2
CR906	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
Q601	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q602	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q603	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q604	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q605	30-31-8431	TR SI NPN	NEC	2SC1843-E
Q607	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q608	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q609	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q610	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q611	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q612	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q613	30-31-7301	TR SI NPN	NEC	2SC1730-L
Q614	30-31-7301	TR SI NPN	NEC	2SC1730-L
Q901	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q902	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q903	31-20-1073	FET IDSS 4.5-7.7MA	SONY	2SK107-3
Q904	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q905	30-10-8381	TR SI PNP	MATSUSITA	2SA838-B
Q906	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q907	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q908	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q909	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q910	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q911	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q912	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q913	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q914	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q915	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q916	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q917	30-10-8441	TR SI PNP	HITACHI	2SA844-D
QCR601	30-31-9071	TR SI NPN	HITACHI	2SC1907

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
Q606-1	31-20-3042	FET PAIR 2SK304 30MA	S8407451
Q606-2	31-20-3042	FET PAIR 2SK304 30MA	S8407451
R601	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R602	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R603	40-27-1152	FXD C FILM 150 OHM 5% 1/4W	
R604	40-27-1392	FXD C FILM 390 OHM 5% 1/4W	
R605	40-27-1392	FXD C FILM 390 OHM 5% 1/4W	
R606	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W	
R607	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W	
R608	40-27-2102	FXD C FILM 1K OHM 5% 1/4W	
R609	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R610	40-27-0682	FXD C FILM 68 OHM 5% 1/4W	
R612	42-73-4800	FXD M FILM 800K OHM 0.5% 1/2W	
R613	42-71-4250	FXD M FILM 250K OHM 0.5% 1/4W 100PPM/DEG	
R614	40-27-3472	FXD C FILM 47K OHM 5% 1/4W	
R615	40-27-4102	FXD C FILM 100K OHM 5% 1/4W	
R616	42-73-5100	FXD M FILM 1M OHM 0.5% 1/2W 100PPM/DEG	
R617	40-27-4472	FXD C FILM 470K OHM 5% 1/4W	
R618	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R619	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R620	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R621	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R622	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W	
R623	40-27-2562	FXD C FILM 5.6K OHM 5% 1/4W	
R624	40-27-1472	FXD C FILM 470 OHM 5% 1/4W	
R625	40-27-2682	FXD C FILM 6.8K OHM 5% 1/4W	
R629	40-27-1152	FXD C FILM 150 OHM 5% 1/4W	
R630	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W	
R631	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W	
R632	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R633	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R634	40-27-1332	FXD C FILM 330 OHM 5% 1/4W	
R635	40-27-1332	FXD C FILM 330 OHM 5% 1/4W	
R636	40-27-4102	FXD C FILM 100K OHM 5% 1/4W	
R637	40-27-4102	FXD C FILM 100K OHM 5% 1/4W	
R638	40-27-5102	FXD C FILM 1M OHM 5% 1/4W	
R639	40-27-5102	FXD C FILM 1M OHM 5% 1/4W	
R640	40-27-5102	FXD C FILM 1M OHM 5% 1/4W	
R641	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R642	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R643	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W	
R644	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W	
R645	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W	
R646	40-27-1182	FXD C FILM 180 OHM 5% 1/4W	
R647	40-27-1182	FXD C FILM 180 OHM 5% 1/4W	
R648	40-27-1222	FXD C FILM 220 OHM 5% 1/4W	
R649	40-27-1222	FXD C FILM 220 OHM 5% 1/4W	
R650	40-27-0562	FXD C FILM 56 OHM 5% 1/4W	
R651	40-27-0562	FXD C FILM 56 OHM 5% 1/4W	
R652	40-27-3102	FXD C FILM 10K OHM 5% 1/4W	
R653	40-27-0332	FXD C FILM 33 OHM 5% 1/4W	
R654	40-27-4472	FXD C FILM 470K OHM 5% 1/4W	
R655	40-27-2272	FXD C FILM 2.7K OHM 5% 1/4W	

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R661	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R662	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R663	40-27-1392	FXD C FILM	390 OHM 5% 1/4W
R665	40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W
R666	40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W
R668	42-72-1680	FXD M FILM	680 OHM 1% 1/4W
R669	42-72-1680	FXD M FILM	680 OHM 1% 1/4W
R671	40-27-0222	FXD C FILM	22 OHM 5% 1/4W
R901	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R902	40-27-2392	FXD C FILM	3.9K OHM 5% 1/4W
R903	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R904	40-27-1152	FXD C FILM	150 OHM 5% 1/4W
R905	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R906	40-27-2562	FXD C FILM	5.6K OHM 5% 1/4W
R907	42-72-2560	FXD M FILM	5.6K OHM 1% 1/4W
R908	42-72-2560	FXD M FILM	5.6K OHM 1% 1/4W
R909	42-72-3100	FXD M FILM	10K OHM 1% 1/4W
R910	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R911	42-71-3500	FXD M FILM	50K OHM 0.5% 1/4W
R912	42-71-3200	FXD M FILM	20K OHM 0.5% 1/4W
R913	42-71-3100	FXD M FILM	10K OHM 0.5% 1/4W
R914	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R915	42-73-5100	FXD M FILM	1M OHM 0.5% 1/2W 100PPM/DEG
R916	42-71-4100	FXD M FILM	100K OHM 0.5% 1/4W
R917	40-27-2102	FXD C FILM	1K OHM 5% 1/4W
R918	42-71-3100	FXD M FILM	10K OHM 0.5% 1/4W
R919	42-71-1990	FXD M FILM	990 OHM 0.5% 1/4W
R920	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R921	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R922	40-27-2682	FXD C FILM	6.8K OHM 5% 1/4W
R923	40-27-2332	FXD C FILM	3.3K OHM 5% 1/4W
R924	42-72-2100	FXD M FILM	1K OHM 1% 1/4W
R926	40-27-3222	FXD C FILM	22K OHM 5% 1/4W
R927	40-27-3222	FXD C FILM	22K OHM 5% 1/4W
R928	40-27-3222	FXD C FILM	22K OHM 5% 1/4W
R929	40-27-3122	FXD C FILM	12K OHM 5% 1/4W
R930	44-07-0110	FXD M GLAZE	RESISTOR NETWORKS 100K OHM X10
R931	40-27-1822	FXD C FILM	820 OHM 5% 1/4W
R932	40-27-1122	FXD C FILM	120 OHM 5% 1/4W
R933	40-27-1102	FXD C FILM	100 OHM 5% 1/4W
R934	40-27-0222	FXD C FILM	22 OHM 5% 1/4W
R935	40-27-0222	FXD C FILM	22 OHM 5% 1/4W
R936	40-27-1272	FXD C FILM	270 OHM 5% 1/4W
R937	40-27-1222	FXD C FILM	220 OHM 5% 1/4W
R938	40-27-1392	FXD C FILM	390 OHM 5% 1/4W
R941	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R942	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
R943	40-27-0102	FXD C FILM	10 OHM 5% 1/4W
RV601	45-01-0550	VAR C COMP	10K/100K OHM B
RV661	48-32-1500	VAR M GLAZE	500 OHM B PV
RV901	48-30-3100	VAR M GLAZE	10K OHM
RV902	48-30-3100	VAR M GLAZE	10K OHM
S601	82-70-5242	LEVER SWITCH	ALPS SLR524-2

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
S602	82-70-5242	LEVER SWITCH	ALPS	SLR524-2
S604	82-70-5221	PUSH SWITCH	ALPS	SLR522-1
U601	30-90-0150	TRANSISTOR ARRAYS 5 NPN	RCA	CA3127E
U602	34-00-0215	J-FET INPUT OPE-AMP	TEXAS INS.	TL081CP
U603	30-90-0141	TRANSISTOR ARRAYS 5 NPN	RCA	CA3086
U901	34-00-0215	J-FET INPUT OPE-AMP	TEXAS INS.	TL081CP
U902	34-69-0010	QUAD BILATERAL SWITCH	TOSHIBA	TC4066BP
U903	35-60-0080	HEX INV BUFFER/CONV	TOSHIBA	TC4009UBP
U904	35-60-0100	TRIPLE 3-INPUT NAND GATE	TOSHIBA	TC4023BP
U905	35-60-0000	QUAD 2-INPUT NAND GATES	TOSHIBA	TC4011BP

A9 ASSEMBLY

C1051	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1052	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1054	52-06-2225	FXD CER 100PF 10% 50V TYPE1		
C1055	52-06-2225	FXD CER 100PF 10% 50V TYPE1		
C1056	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1057	57-10-1150	VAR CER 25-22.5PF		
C1058	52-96-1140	FXD COMP 0.68PF 10% 500V		
C1059	52-96-1140	FXD COMP 0.68PF 10% 500V		
C1060	54-00-0311	FXD ELECT 10UF 50V		
C1061	54-00-0311	FXD ELECT 10UF 50V		
C1062	54-00-0311	FXD ELECT 10UF 50V		
C1063	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1064	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1065	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1066	50-77-3500	FXD PLSTC FILM 0.047UF 20% 250V		
C1067	50-77-3500	FXD PLSTC FILM 0.047UF 20% 250V		
C1068	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C1071	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1072	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C1073	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C1074	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C1075	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1076	54-00-0311	FXD ELECT 10UF 50V		
C1077	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
CR1053	32-92-0022	ZENER VZ 2.1 - 2.3V	HITACHI	HZ2B-3
Q1051	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q1052	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q1053	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q1054	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q1055	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q1056	30-31-9071	TR SI NPN	HITACHI	2SC1907
Q1057	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q1058	30-11-0051	TR SI PNP	NEC	2SA1005-L
Q1059	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q1060	30-30-9451	TR SI NPN	NEC	2SC945-Q
Q1061	30-40-6681	TR SI NPN	HITACHI	2SD668A-C

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
Q1062	30-40-6681	TR SI NPN	HITACHI	2SD668A-C
Q1063	30-20-6481	TR SI PNP	HITACHI	2SB648A
Q1064	30-20-6481	TR SI PNP	HITACHI	2SB648A
Q1065	30-31-9071	TR SI NPN	HITACHI	2SC1907
QCR1051	30-31-7301	TR SI NPN	NEC	2SC1730-L
QCR1052	30-31-7301	TR SI NPN	NEC	2SC1730-L
R1051	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R1052	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R1053	42-72-1470	FXD M FILM 470 OHM 1% 1/4W		
R1054	40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R1055	42-72-1470	FXD M FILM 470 OHM 1% 1/4W		
R1056	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R1057	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R1058	40-27-2332	FXD C FILM 3.3K OHM 5% 1/4W		
R1059	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W		
R1060	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W		
R1061	40-27-2152	FXD C FILM 1.5K OHM 5% 1/4W		
R1062	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R1063	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R1064	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W		
R1065	40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W		
R1066	40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W		
R1067	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R1068	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R1069	40-27-1222	FXD C FILM 220 OHM 5% 1/4W		
R1070	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R1071	40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R1072	40-27-3332	FXD C FILM 33K OHM 5% 1/4W		
R1073	40-27-3332	FXD C FILM 33K OHM 5% 1/4W		
R1074	40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R1075	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R1076	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R1077	44-91-3470	FXD M OXIDE 47K OHM 5% 1W		
R1078	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R1079	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		
R1080	44-91-3470	FXD M OXIDE 47K OHM 5% 1W		
R1081	40-27-4152	FXD C FILM 150K OHM 5% 1/4W		
R1082	40-27-4152	FXD C FILM 150K OHM 5% 1/4W		
R1083	40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R1084	40-27-2102	FXD C FILM 1K OHM 5% 1/4W		
R1085	40-27-1332	FXD C FILM 330 OHM 5% 1/4W		
R1086	40-27-0222	FXD C FILM 22 OHM 5% 1/4W		
R1087	40-27-1332	FXD C FILM 330 OHM 5% 1/4W		
R1088	40-27-0222	FXD C FILM 22 OHM 5% 1/4W		
R1089	40-27-3122	FXD C FILM 12K OHM 5% 1/4W		
R1090	44-91-3680	FXD M OXIDE 68K OHM 5% 1W		
R1091	44-91-3680	FXD M OXIDE 68K OHM 5% 1W		
R1092	40-27-0472	FXD C FILM 47 OHM 5% 1/4W		
R1093	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R1094	40-27-2392	FXD C FILM 3.9K OHM 5% 1/4W		
R1095	40-27-1102	FXD C FILM 100 OHM 5% 1/4W		
R1096	40-27-2222	FXD C FILM 2.2K OHM 5% 1/4W		

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R1097	40-27-3472	FXD C FILM 47K OHM 5% 1/4W	
RV1051	48-31-2200	VAR M GLAZE 2K OHM B PH	
RV1052	48-31-2500	VAR M GLAZE 5K OHM B PH	
RV1053	48-31-3200	FXD M GLAZE 20K OHM B PH	

A10 ASSEMBLY

C1101	54-00-0311	FXD ELECT 10UF 50V		
C1102	55-37-2050	FXD TANT ELECT 1UF 35V		
C1103	50-67-0050	FXD PLSTC FILM 0.047UF 10% 100V		
C1104	54-00-0121	FXD ELECT 100UF 25V		
C1105	54-00-0121	FXD ELECT 100UF 25V		
C1106	52-98-1000	FXD CER 4700PF +80-20% 3.15KV TYPE1		
C1107	52-98-1000	FXD CER 4700PF +80-20% 3.15KV TYPE1		
C1108	52-98-1000	FXD CER 4700PF +80-20% 3.15KV TYPE1		
C1109	52-98-1000	FXD CER 4700PF +80-20% 3.15KV TYPE1		
C1110	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C1111	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C1112	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C1113	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C1114	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C1115	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1		
C1116	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1117	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1118	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1119	52-08-5145	FXD CER 22PF 10% 2KV TYPE1		
C1120	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
CR1101	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1102	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN	GHV-06SSN
CR1103	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR1104	32-92-0240	ZENER VZ 22.8-25.6V P 0.4W	NEC	RD24JB
CR1105	32-90-1820	DIODE VR 2KV FAST RECOVERY	HITACHI	ERB26-20
CR1106	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR1107	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR1108	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR1109	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR1110	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR1111	32-30-0830	DIODE VR 250V IO 200MA	HITACHI	1SS83
CR1112	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
Q1101	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q1102	30-31-8431	TR SI NPN	NEC	2SC1843-E
Q1103	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q1104	30-10-8441	TR SI PNP	HITACHI	2SA844-D
Q1105	30-40-8802	TR SI NPN	TOSHIBA	2SD880-Y
Q1106	30-32-3710	TR SI NPN	NEC	2SC2371-L
R1101	40-27-0102	FXD C FILM 10 OHM 5% 1/4W		
R1102	42-72-2560	FXD M FILM 5.6K OHM 1% 1/4W		
R1103	42-72-2560	FXD M FILM 5.6K OHM 1% 1/4W		

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
R1104	42-72-3560	FXD M FILM 56K OHM 1% 1/4W	
R1105	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R1106	40-27-0472	FXD C FILM 47 OHM 5% 1/4W	
R1107	40-27-4222	FXD C FILM 220K OHM 5% 1/4W	
R1108	40-27-1682	FXD C FILM 680 OHM 5% 1/4W	
R1109	40-27-3222	FXD C FILM 22K OHM 5% 1/4W	
R1110	40-27-2102	FXD C FILM 1K OHM 5% 1/4W	
R1111	40-27-2102	FXD C FILM 1K OHM 5% 1/4W	
R1112	40-37-8222	FXD C FILM 2.2 OHM 5% 1/2W	
R1113	40-27-0332	FXD C FILM 33 OHM 5% 1/4W	
R1114	42-44-0280	FXD M GLAZE 10M OHM 1% 1.6W	
R1115	42-44-0280	FXD M GLAZE 10M OHM 1% 1.6W	
R1116	40-37-3221	FXD C FILM 22K OHM 5% 1/2W	
R1118	40-37-5221	FXD C FILM 2.2M OHM 5% 1/2W	
R1119	40-37-5221	FXD C FILM 2.2M OHM 5% 1/2W	
R1120	40-27-4152	FXD C FILM 150K OHM 5% 1/4W	
R1121	42-44-0280	FXD M GLAZE 10M OHM 1% 1.6W	
R1122	40-37-6101	FXD C FILM 10M OHM 5% 1/2W	
R1123	40-37-6101	FXD C FILM 10M OHM 5% 1/2W	
R1124	40-37-5221	FXD C FILM 2.2M OHM 5% 1/2W	
R1125	40-27-2332	FXD C FILM 3.3K OHM 5% 1/4W	
R1126	40-37-6101	FXD C FILM 10M OHM 5% 1/2W	
R1127	40-37-6101	FXD C FILM 10M OHM 5% 1/2W	
R1128	40-27-2102	FXD C FILM 1K OHM 5% 1/4W	
R1129	40-27-0000	JUMPER PARTS	
R1131	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R1132	40-27-1102	FXD C FILM 100 OHM 5% 1/4W	
R1133	40-27-4102	FXD C FILM 100K OHM 5% 1/4W	
RV1101	48-32-3100	VAR M GLAZE 10K OHM B	
RV1102	48-26-5220	VAR M GLAZE 2.2M OHM	
RV1103	48-26-4101	VAR M GLAZE 100K OHM	
RV1104	48-26-4101	VAR M GLAZE 100K OHM	
RV1105	48-26-4101	VAR M GLAZE 100K OHM	
T1101	63-92-0130	CONVERTOR TRANS	KIKUSUI S810115
V1101	23-70-0100	LAMP NEON	
V1102	23-70-0100	LAMP NEON	
Z1101	39-00-0130	SURGE ABSORBER	

A11 ASSEMBLY

C1141	54-00-0311	FXD ELECT 100UF 50V	
C1142	52-06-2204	FXD CER 68P 10% 50V TYPE1	
C1143	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	
C1144	57-10-1190	VAR CER 3-10PF	
C1145	52-96-1140	FXD COMP 0.68PF 10% 500V	
C1146	52-96-1140	FXD COMP 0.68PF 10% 500V	
C1147	52-03-3469	FXD CER 0.01UF +100-0% 50JV TYPE2	
C1148	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2	

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150	
C1149	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1150	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1151	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1152	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1153	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1154	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C1155	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1156	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1157	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1158	54-00-0311	FXD ELECT 10UF 50V		
C1160	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1161	54-00-0311	FXD ELECT 10UF 50V		
C1162	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C1163	52-06-2102	FXD CER 10P 10% 50V TYPE1		
C1164	52-06-2145	FXD CER 22PF 10% 500V TYPE1		
C1211	50-67-0040	FXD PLSTC FILM 0.022UF 10% 100V		
C1213	54-60-1630	FXD ELECT 100MF 160V		
C1214	54-60-1550	FXD ELECT 1UF 160V		
C1216	54-00-0522	FXD ELECT 220MF 100V		
C1217	54-60-1550	FXD ELECT 1UF 160V		
C1218	54-30-1650	FXD ELECT 2200UF 25V		
C1219	54-30-1650	FXD ELECT 2200UF 25V		
C1220	54-30-1650	FXD ELECT 2200UF 25V		
C1223	54-00-0311	FXD ELECT 10UF 50V		
C1224	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C1225	52-01-3345	FXD CER 1000PF 10% 500V TYPE2		
C1228	54-00-0311	FXD ELECT 10UF 50V		
C1229	54-00-0032	FXD ELECT 2200UF 16V		
C1231	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1232	52-03-3469	FXD CER 0.01UF +100-0% 500V TYPE2		
C1233	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C1234	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C1235	52-05-1498	FXD CER 0.1UF +80-20% 25V TYPE2		
C1236	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		
C1237	52-01-3385	FXD CER 2220PF 10% 500V TYPE2		
C1239	54-60-1550	FXD ELECT 1UF 160V		
C1240	54-00-0311	FXD ELECT 10UF 50V		
CR1141	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1142	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1144	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1145	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1146	32-92-0022	ZENER VZ 2.1 - 2.3V	HITACHI	HZ2B-3
CR1147	32-11-5830	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1148	32-91-2300	ZENER VZ 135 - 165V	TOSHIBA	1Z150
CR1211	32-90-0870	DIODE BRIGE	SINDENGEN	SIV840
CR1212	32-90-0520	DIODE	HITACHI	V06G
CR1213	32-90-0520	DIODE	HITACHI	V06G
CR1214	32-90-0520	DIODE	HITACHI	V06G
CR1215	32-90-0520	DIODE	HITACHI	V06G
CR1216	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA	1S1588
CR1217	32-90-1152	DIODE BRIGE VRM 200V IO 2A	TOSHIBA	2S4B41
CR1218	32-90-1152	DIODE BRIGE VRM 200V IO 2A	TOSHIBA	2S4B41
C1226 *	52-05-2468	FXD CER 0.01UF +80-20% 50V TYPE2		

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS5150
Q1141	30-10-8381	TR SI PNP	MATSUSITA 2SA838-B
Q1142	30-10-8381	TR SI PNP	MATSUSITA 2SA838-B
Q1143	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q1145	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q1146	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q1147	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q1148	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q1149	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q1150	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q1151	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q1152	30-31-9071	TR SI NPN	HITACHI 2SC1907
Q1153	30-40-6681	TR SI NPN	HITACHI 2SD668A-C
Q1154	30-40-6681	TR SI NPN	HITACHI 2SD668A-C
Q1155	30-20-6481	TR SI PNP	HITACHI 2SB648A
Q1156	30-20-6481	TR SI PNP	HITACHI 2SB648A
Q1211	30-31-5051	TR SI NPN	NEC 2SC1505-K
Q1212	30-20-8341	TR SI PNP	TOSHIBA 2SB834-Y
Q1213	30-32-3710	TR SI NPN	NEC 2SC2371-L
Q1214	30-10-8441	TR SI PNP	HITACHI 2SA844-D
Q1215	30-20-8341	TR SI PNP	TOSHIBA 2SB834-Y
Q1216	30-40-8802	TR SI NPN	TOSHIBA 2SD880-Y
Q1217	30-30-9451	TR SI NPN	NEC 2SC945-Q
Q1218	30-40-8802	TR SI NPN	TOSHIBA 2SD880-Y
Q1219	30-40-8802	TR SI NPN	TOSHIBA 2SD880-Y

R1141	40-27-2472	FXD C FILM	4.7K	OHM	5% 1/4W
R1142	40-27-2102	FXD C FILM	1K	OHM	5% 1/4W
R1143	40-27-2562	FXD C FILM	5.6K	OHM	5% 1/4W
R1144	42-72-2560	FXD M FILM	5.6K	OHM	1% 1/4W
R1145	40-27-2392	FXD C FILM	3.9K	OHM	5% 1/4W
R1146	40-27-2222	FXD C FILM	2.2K	OHM	5% 1/4W
R1148	40-27-1221	FXD C FILM	220	OHM	5% 1/4W
R1149	40-27-1221	FXD C FILM	220	OHM	5% 1/4W
R1150	40-27-1221	FXD C FILM	220	OHM	5% 1/4W
R1151	40-27-3102	FXD C FILM	10K	OHM	5% 1/4W
R1152	40-27-1102	FXD C FILM	100	OHM	5% 1/4W
R1153	40-27-1102	FXD C FILM	100	OHM	5% 1/4W
R1154	40-27-2332	FXD C FILM	3.3K	OHM	5% 1/4W
R1155	40-27-2302	FXD C FILM	3K	OHM	5% 1/4W
R1156	40-27-3332	FXD C FILM	33K	OHM	5% 1/4W
R1157	40-27-1561	FXD C FILM	560	OHM	5% 1/4W
R1158	40-27-1560	FXD C FILM	560	OHM	5% 1/4W
R1159	44-91-3560	FXD M OXIDE	56K	OHM	5% 1W
R1160	40-27-2222	FXD C FILM	2.2K	OHM	5% 1/4W
R1161	40-27-2222	FXD C FILM	2.2K	OHM	5% 1/4W
R1162	40-27-2222	FXD C FILM	2.2K	OHM	5% 1/4W
R1163	40-27-2222	FXD C FILM	2.2K	OHM	5% 1/4W
R1164	40-27-4152	FXD C FILM	150K	OHM	5% 1/4W
R1165	40-27-4152	FXD C FILM	150K	OHM	5% 1/4W
R1166	40-27-2102	FXD C FILM	1K	OHM	5% 1/4W
R1167	40-27-2102	FXD C FILM	1K	OHM	5% 1/4W
R1168	40-27-1472	FXD C FILM	470	OHM	5% 1/4W
R1169	40-27-0472	FXD C FILM	47	OHM	5% 1/4W

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION					
R1170	40-27-1472	FXD	C	FILM	470	OHM	5% 1/4W
R1171	40-27-0102	FXD	C	FILM	10	OHM	5% 1/4W
R1172	40-27-0472	FXD	C	FILM	47	OHM	5% 1/4W
R1173	40-27-2182	FXD	C	FILM	1.8K	OHM	5% 1/4W
R1174	44-91-3680	FXD	M	OXIDE	68K	OHM	5% 1W
R1176	40-27-1562	FXD	C	FILM	560	OHM	5% 1/4W
R1177	40-27-1102	FXD	C	FILM	100	OHM	5% 1/4W
R1178	40-27-0102	FXD	C	FILM	10	OHM	5% 1/4W
R1179	40-27-0102	FXD	C	FILM	10	OHM	5% 1/4W
R1180	40-27-3102	FXD	C	FILM	10K	OHM	5% 1/4W
R1211	40-37-5221	FXD	C	FILM	2.2M	OHM	5% 1/2W
R1212	40-37-5221	FXD	C	FILM	2.2M	OHM	5% 1/2W
R1213	40-37-3101	FXD	C	FILM	10K	OHM	5% 1/2W
R1214	40-27-8472	FXD	C	FILM	4.7	OHM	5% 1/4W
R1215	42-72-4100	FXD	M	FILM	100K	OHM	1% 1/4W
R1216	40-27-1562	FXD	C	FILM	560	OHM	5% 1/4W
R1217	42-72-3470	FXD	M	FILM	47K	OHM	1% 1/4W
R1218	40-27-3472	FXD	C	FILM	47K	OHM	5% 1/4W
R1219	40-27-2102	FXD	C	FILM	1K	OHM	5% 1/4W
R1220	40-27-2102	FXD	C	FILM	1K	OHM	5% 1/4W
R1221	40-27-0102	FXD	C	FILM	10	OHM	5% 1/4W
R1222	42-72-3560	FXD	M	FILM	56K	OHM	1% 1/4W
R1223	42-72-3120	FXD	M	FILM	12K	OHM	1% 1/4W
R1224	44-92-0680	FXD	M	OXIDE	68	OHM	5% 1W
R1225	40-27-1152	FXD	C	FILM	150	OHM	5% 1/4W
R1226	40-37-8222	FXD	C	FILM	2.2	OHM	5% 1/2W
R1227	40-37-8222	FXD	C	FILM	2.2	OHM	5% 1/2W
R1228	42-72-1680	FXD	M	FILM	680	OHM	1% 1/4W
R1229	40-27-2152	FXD	C	FILM	1.5K	OHM	5% 1/4W
R1230	42-72-3120	FXD	M	FILM	12K	OHM	1% 1/4W
R1231	42-72-3120	FXD	M	FILM	12K	OHM	1% 1/4W
R1232	40-37-8222	FXD	C	FILM	2.2	OHM	5% 1/2W
R1233	40-37-8222	FXD	C	FILM	2.2	OHM	5% 1/2W
R1234	40-27-1152	FXD	C	FILM	150	OHM	5% 1/4W
R1235	44-92-0680	FXD	M	OXIDE	68	OHM	5% 1W
R1236	44-92-0680	FXD	M	OXIDE	68	OHM	5% 1W
R1238	44-91-0010	FXD	M	OXIDE	1	OHM	5% 1W
R1239	40-27-2102	FXD	C	FILM	1K	OHM	5% 1/4W
R1240	40-27-1222	FXD	C	FILM	220	OHM	5% 1/4W
R1241	42-72-2390	FXD	M	FILM	3.9K	OHM	1% 1/4W
R1242	42-72-2910	FXD	M	FILM	9.1K	OHM	1% 1/4W
R1243	40-27-3102	FXD	C	FILM	10K	OHM	5% 1/4W
R1245	40-27-4102	FXD	C	FILM	100K	OHM	5% 1/4W
RV1141	48-31-3100	FXD	M	GLAZE	10K	OHM	B PH
RV1142	48-31-3100	FXD	M	GLAZE	10K	OHM	B PH
RV1211	48-29-2100	VAR	M	GLAZE	1K	OHM	
U1211	34-00-0240	DUAL OPE-AMP				NEC	UPC4558C
U1212	34-40-0070	REGULATOR +/-15V DUAL				TOSHIBA	TA7179P

A12 ASSEMBLY

REFERENCE DESIGNATOR	KIKUSUI PARTS NO.	DESCRIPTION	COS6150
C1121	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1	
C1122	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1	
C1123	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1	
C1124	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1	
C1125	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1	
C1126	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1	
C1127	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1	
C1128	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1	
C1129	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1	
C1130	52-98-1010	FXD CER 1000PF +80-20% 6.3KV TYPE1	
CR1121	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN GHV-06SSN
CR1122	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN GHV-06SSN
CR1123	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN GHV-06SSN
CR1124	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN GHV-06SSN
CR1125	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN GHV-06SSN
CR1126	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN GHV-06SSN
CR1127	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN GHV-06SSN
CR1128	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN GHV-06SSN
CR1129	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN GHV-06SSN
CR1130	32-90-1951	DIODE VR 6KV FAST RECOVERY	SANKEN GHV-06SSN
R1130	40-37-6101	FXD C FILM 10M OHM 5% 1/2W	
A13 ASSEMBLY			
B26	84-38-0805	CONNECTOR P SIDE	
RV1201	45-01-0530	VAR C COMP 5K OHM	
A14 ASSEMBLY			
C791	52-01-3345	FXD CER 1000PF 10% 500V TYPE2	
CR721	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA 1S1588
CR722	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA 1S1588
CR723	32-11-5880	DIODE VR 30V IO 120MA	TOSHIBA 1S1588
R791	40-27-2682	FXD C FILM 6.8K OHM 5% 1/4W	
R792	40-27-1392	FXD C FILM 390 OHM 5% 1/4W	
R793	40-27-2122	FXD C FILM 1.2K OHM 5% 1/4W	
S701	81-03-0270	PUSH SWITCH	ALPS SUE3L

12. MECHANICAL ASSEMBLY DRAWINGS

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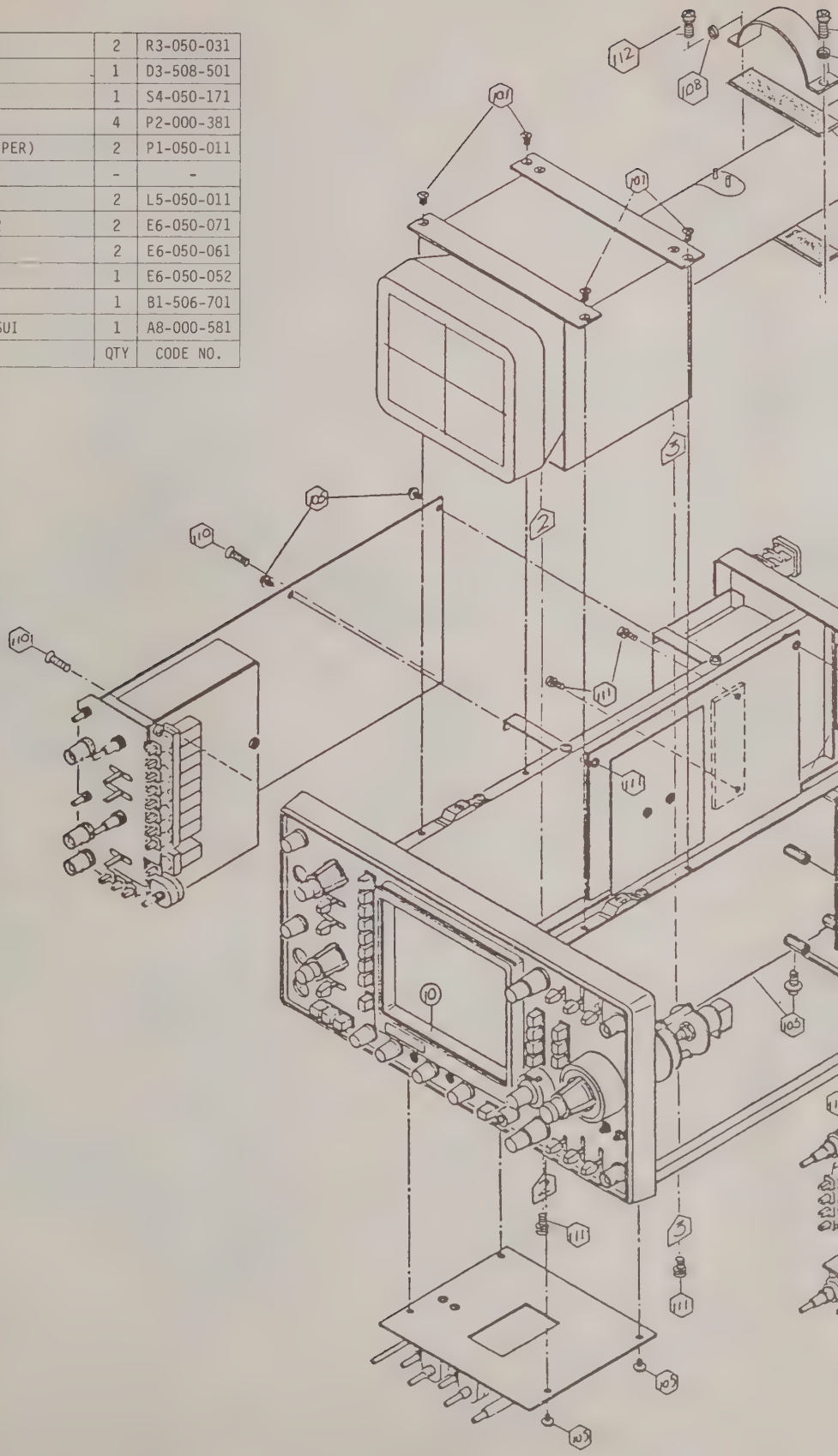
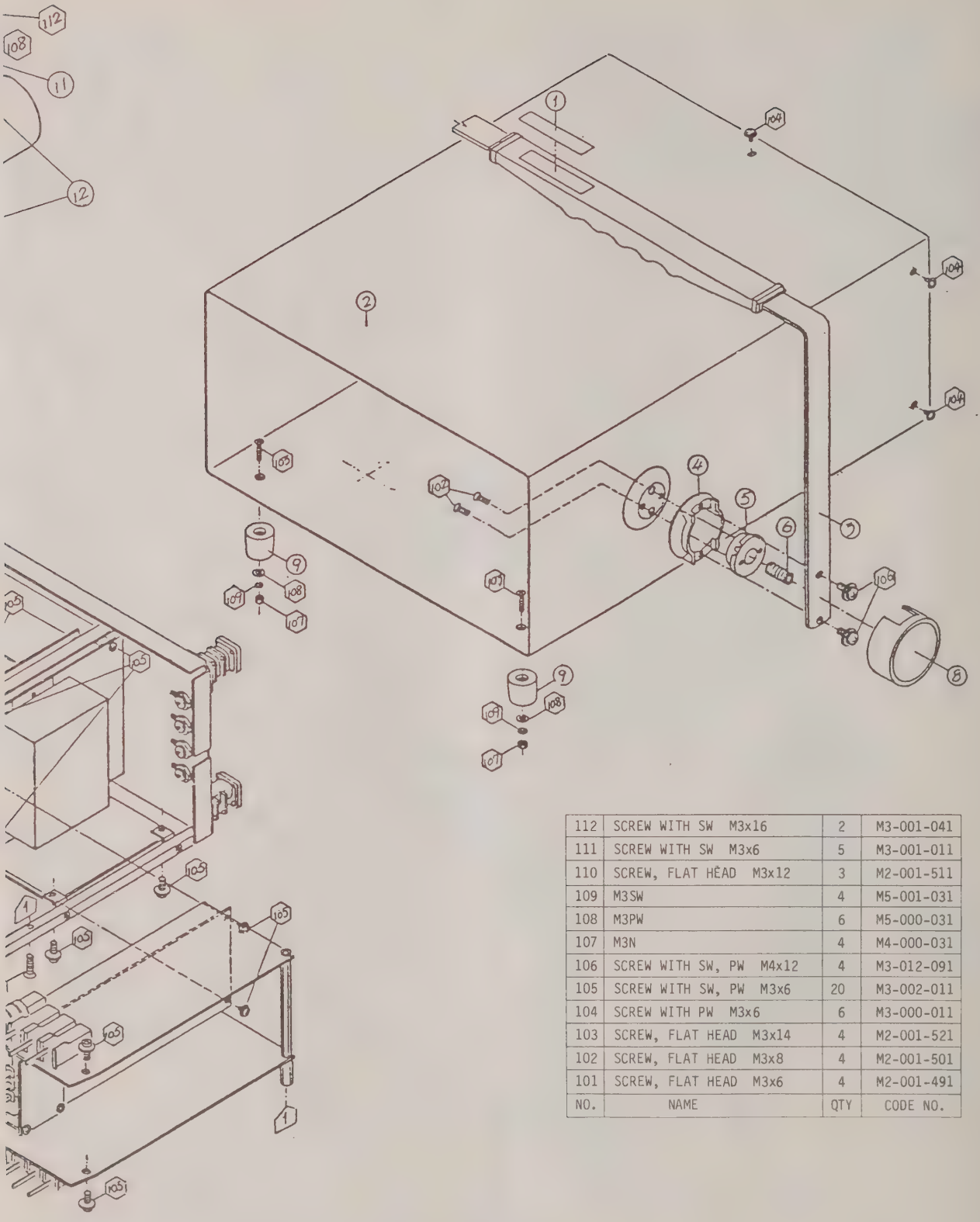
SUB FRONT PANEL ASSEMBLY	319627	220
INTENSITY CIRCUIT ASSEMBLY	319293	221
POWER SUPPLY ASSEMBLY	319294	222
HIGH VOLTAGE POWER ASSEMBLY	319628	223
VERTICAL CIRCUIT ASSEMBLY	320539	224
VERTICAL FINAL ASSEMBLY	320540	225
HORIZONTAL CIRCUIT ASSEMBLY	319298	226
FAN ASSEMBLY		227

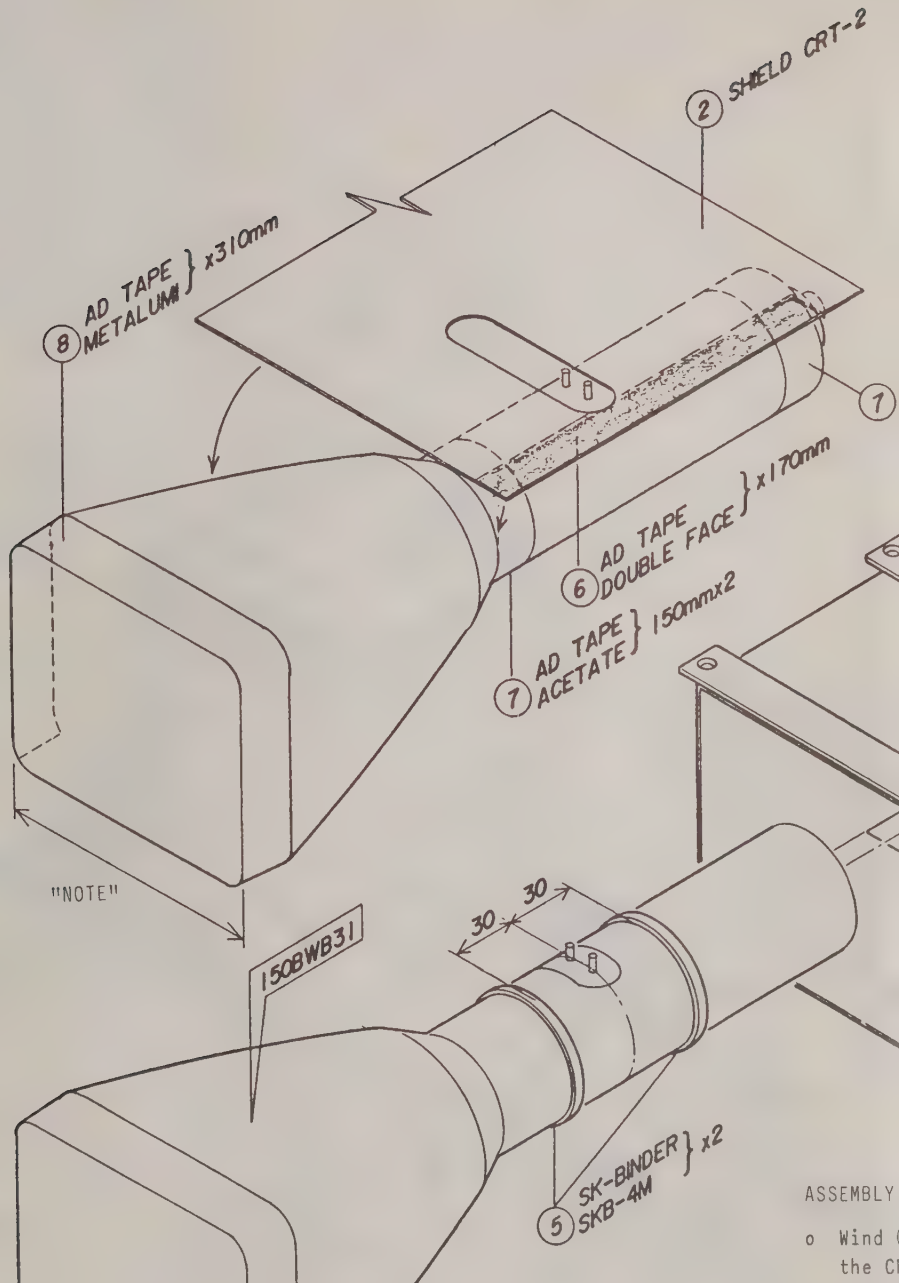
NO.	NAME	QTY	CODE NO.
12	SPACER 20x80x3	2	R3-050-031
11	BRACKET CRT-U	1	D3-508-501
10	FILTER SCREEN	1	S4-050-171
9	FOOT 20-17	4	P2-000-381
8	CAP (HANDLE STOPPER)	2	P1-050-011
7	-	-	-
6	SPRING (HANDLE)	2	L5-050-011
5	HANDLE STOPPER-2	2	E6-050-071
4	HANDLE STOPPER-1	2	E6-050-061
3	CARRYING HANDLE	1	E6-050-052
2	CASE COS6100	1	B1-506-701
1	NAME PLATE KIKUSUI	1	A8-000-581





112	SCREW WITH SW M3x16	2	M3-001-041
111	SCREW WITH SW M3x6	5	M3-001-011
110	SCREW, FLAT HEAD M3x12	3	M2-001-511
109	M3SW	4	M5-001-031
108	M3PW	6	M5-000-031
107	M3N	4	M4-000-031
106	SCREW WITH SW, PW M4x12	4	M3-012-091
105	SCREW WITH SW, PW M3x6	20	M3-002-011
104	SCREW WITH PW M3x6	6	M3-000-011
103	SCREW, FLAT HEAD M3x14	4	M2-001-521
102	SCREW, FLAT HEAD M3x8	4	M2-001-501
101	SCREW, FLAT HEAD M3x6	4	M2-001-491
NO.	NAME	QTY	CODE NO.

MAIN CHASSIS AND CASE ASSEMBLY 320536



ASSEMBLY

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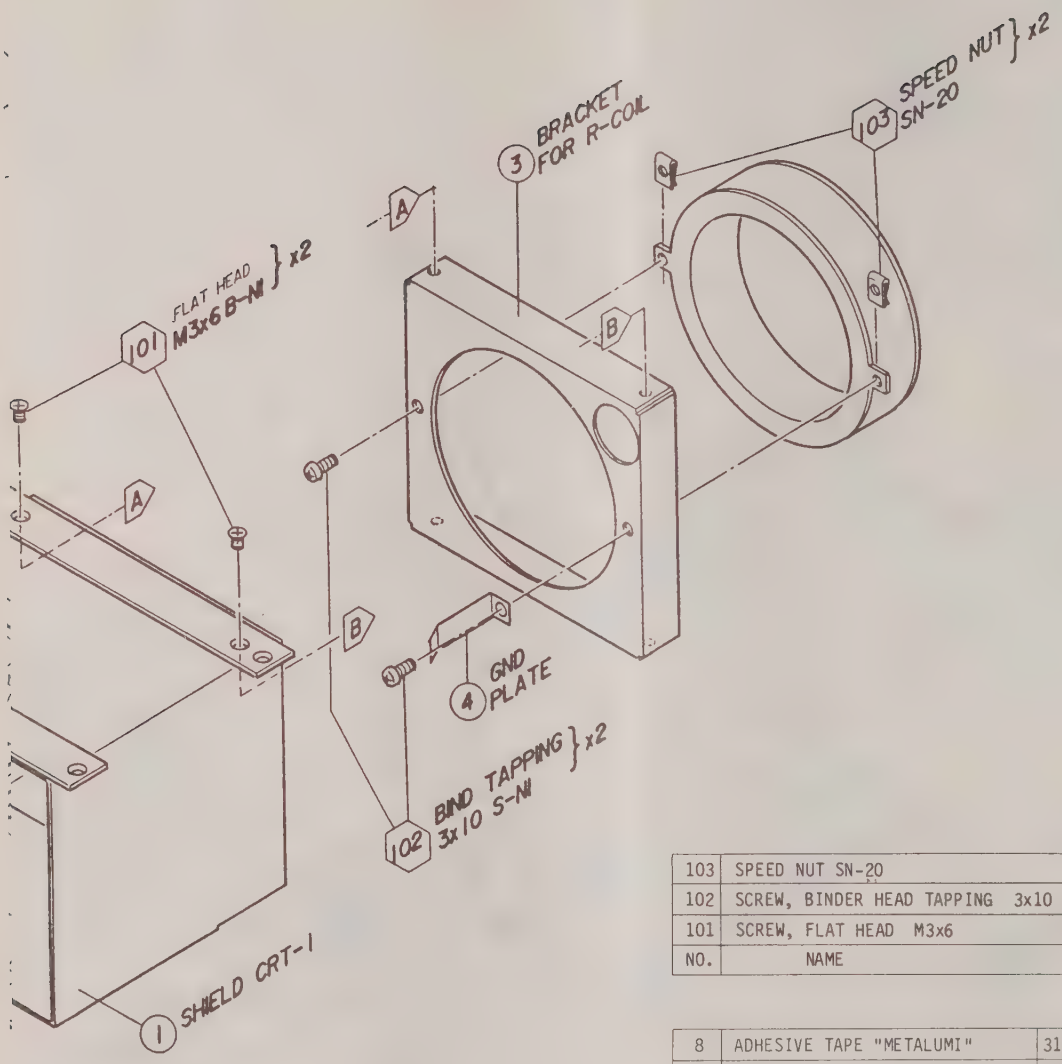


103	SPEED NUT SN-20	4	M8-000-391
102	SCREW, BINDER HEAD TAPPING 3x10	2	M2-015-021
101	SCREW, FLAT HEAD M3x6	2	M2-001-491
NO.	NAME	QTY	CODE NO.

8	ADHESIVE TAPE "METALUMI"	310mm	T4-000-181
7	ADHESIVE TAPE "ACETATE" 571S	300mm	T4-000-131
6	DOUBLE FACE TAPE	170mm	T4-000-091
5	SK-BINDER SKB-4M	2	P4-000-575
4	GND PLATE	1	E4-508-501
3	BRACKET FOR R-COIL	1	D3-508-504
2	SHIELD CRT-2	1	C8-508-502
1	SHIELD CRT-1	1	C8-508-501
NO.	NAME	QTY	CODE NO.

PROCEDURE:

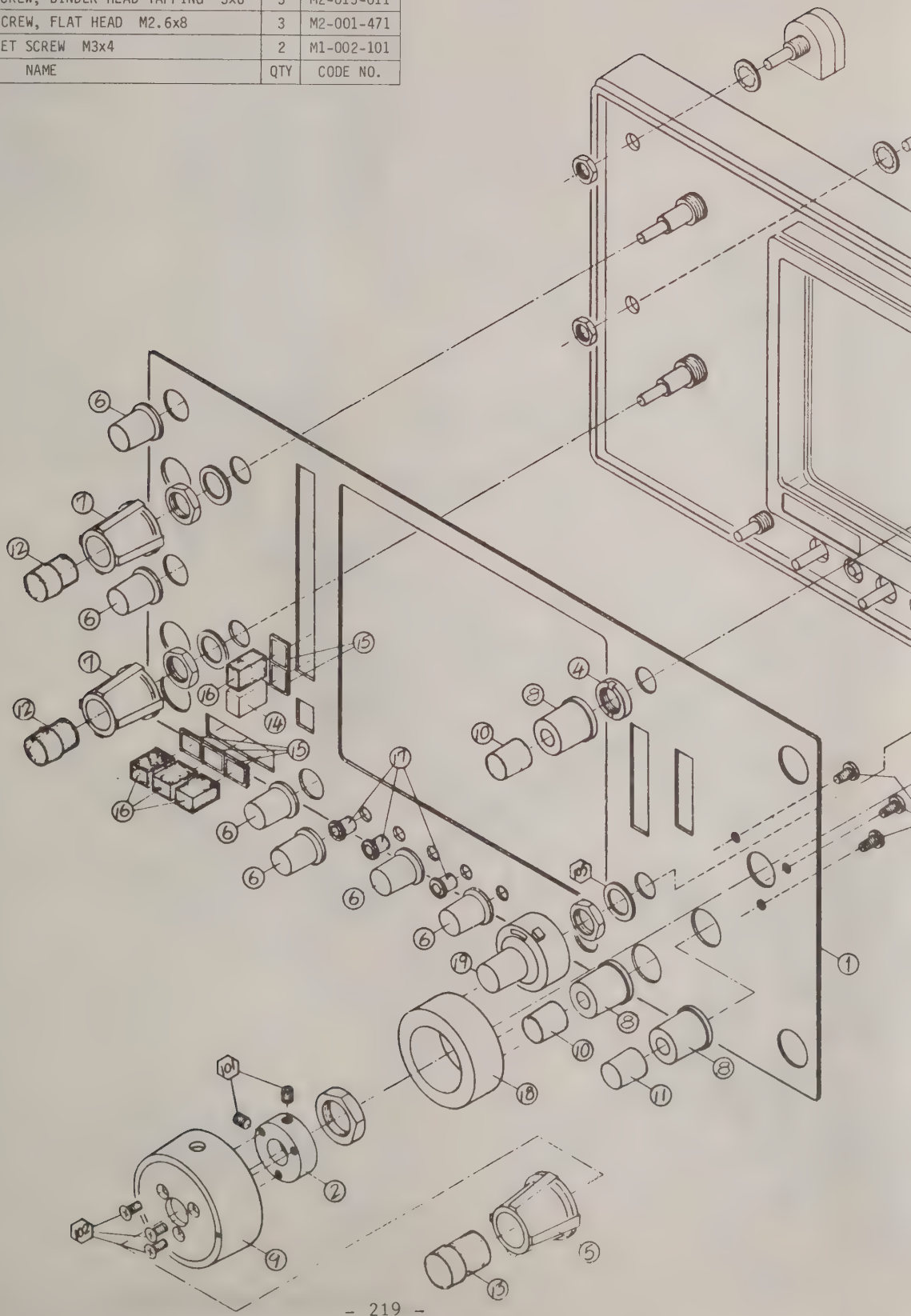
(7) ACETATE TAPE at two positions on
T as illustrated.

(6) DOUBLE FACE TAPE at the end of
IELD CRT-2 as illustrated.

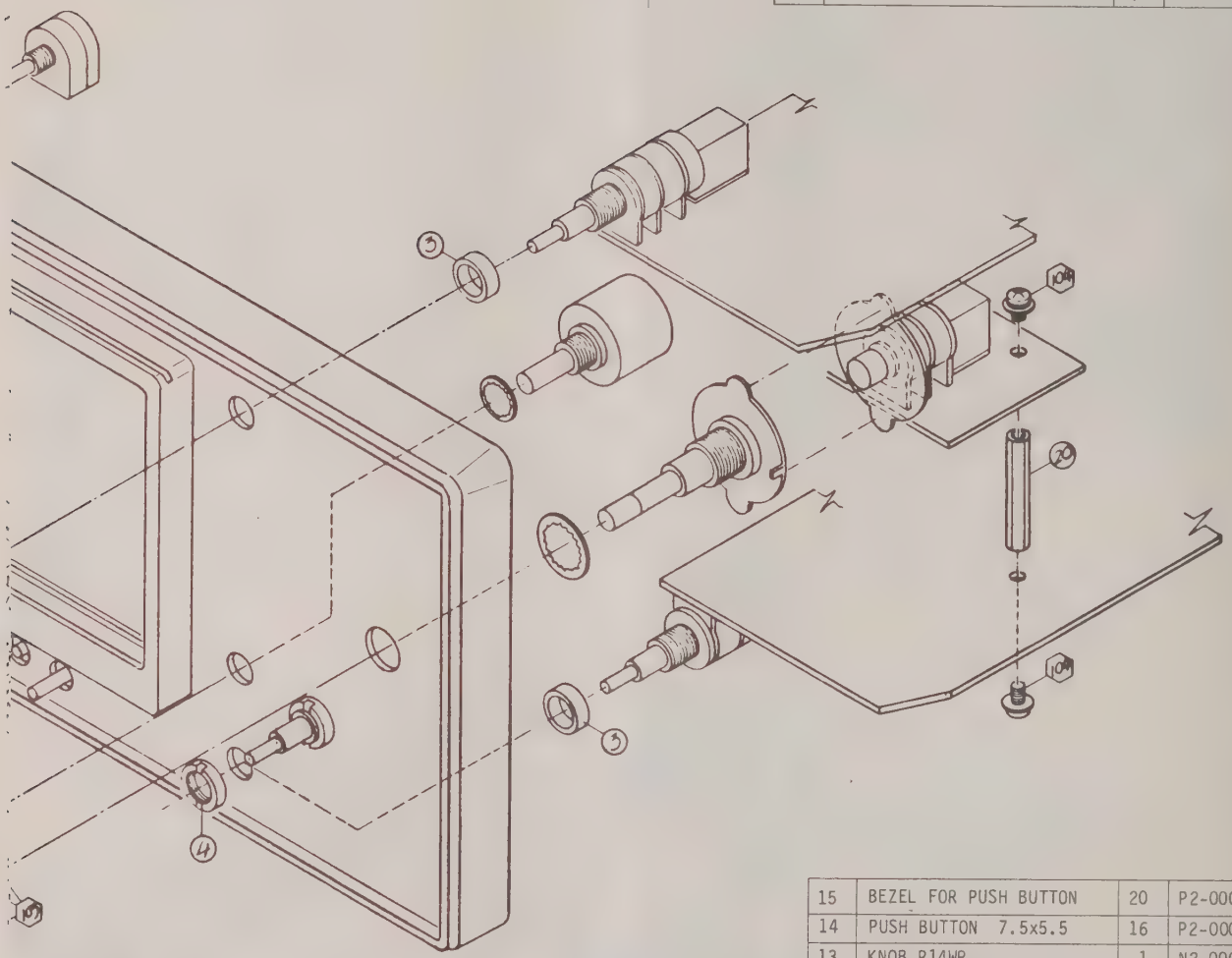
the oblong hole of (6) SHIELD CRT-2
he side pins of the CRT as illus-
, attach the DOUBLE FACE TAPE side
shield onto the CRT, wind the other
of the shield onto the CRT exercising
so that no gaps are formed, and clamp
ield with (5) SK BINDERS.

ost 8 METALUMI TAPE on the portion
approx. 120 mm) indicated by "NOTE."

NO.	NAME	QTY	CODE NO.
105	WASHER DIA 14-9 TO.5	1	M8-000-351
104	SCREW, WITH SW, PW M3x6	2	M3-002-011
103	SCREW, BINDER HEAD TAPPING 3x6	3	M2-015-011
102	SCREW, FLAT HEAD M2.6x8	3	M2-001-471
101	SET SCREW M3x4	2	M1-002-101



NO.	NAME	QTY	CODE NO.
20	SPACER HEX 3-34	1	L3-506-703
19	MGS-20 MULTI DIAL	1	W1-000-013
18	DIAL R42WB	1	S2-506-701
17	BUSHING B-187-125	3	P4-000-701
16	PUSH BUTTON 7.5x5.5 BROWN	4	P2-000-371

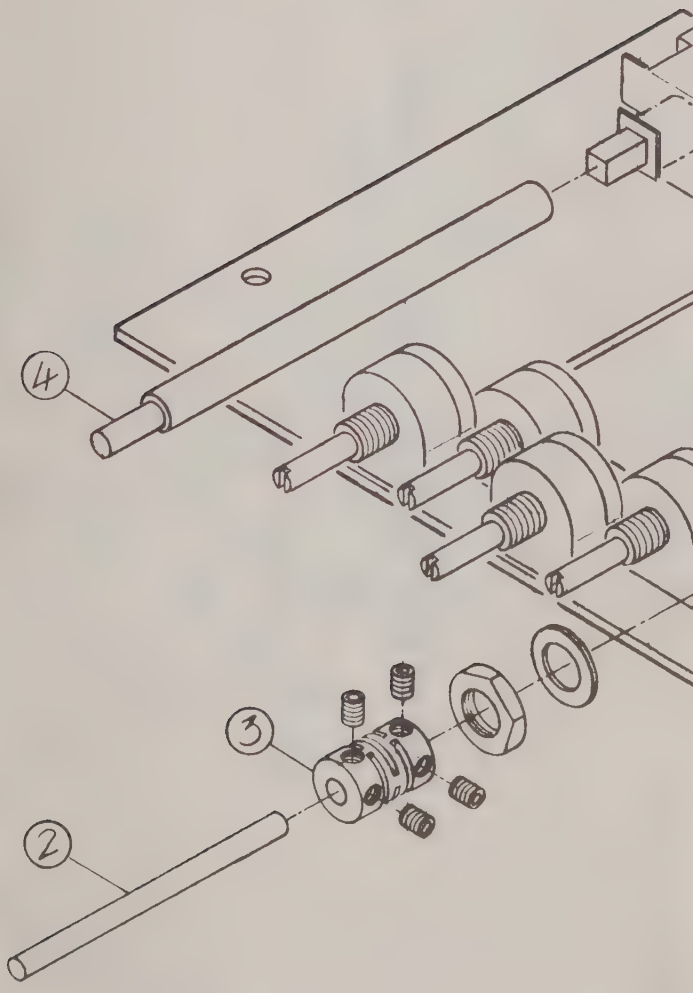


NO.	NAME	QTY	CODE NO.
15	BEZEL FOR PUSH BUTTON	20	P2-000-331
14	PUSH BUTTON 7.5x5.5	16	P2-000-321
13	KNOB R14WR	1	N2-000-061
12	KNOB R12WR-2.5	2	N2-000-051
11	KNOB R10SG-3.2	1	N1-001-111
10	KNOB R10SG-3.2 BEIGE	2	N1-001-101
9	KNOB R42WB	1	N1-001-091
8	KNOB R14WG	3	N1-001-071
7	KNOB D18WG	2	N1-001-061
6	KNOB R12SG-3.2	6	N1-001-041
5	KNOB D22WG	1	N1-001-031
4	NUT, LOCK TYPE 9-M	2	M8-000-151
3	COLLAR 9.2-4-12	2	L2-000-091
2	COUPLING (R42WB)	1	K7-563-021
1	PANEL FRONT COS6100	1	A1-506-701

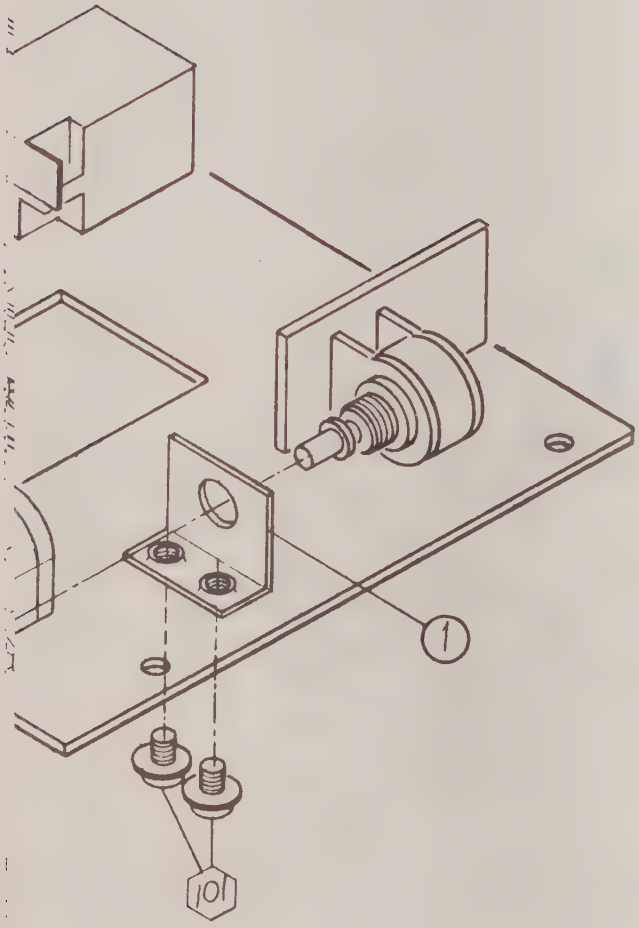
NO.	NAME	QTY	CODE NO.
1	PANEL FRONT COS6150	1	A1-508-501

FRONT PANEL ASSEMBLY 319626

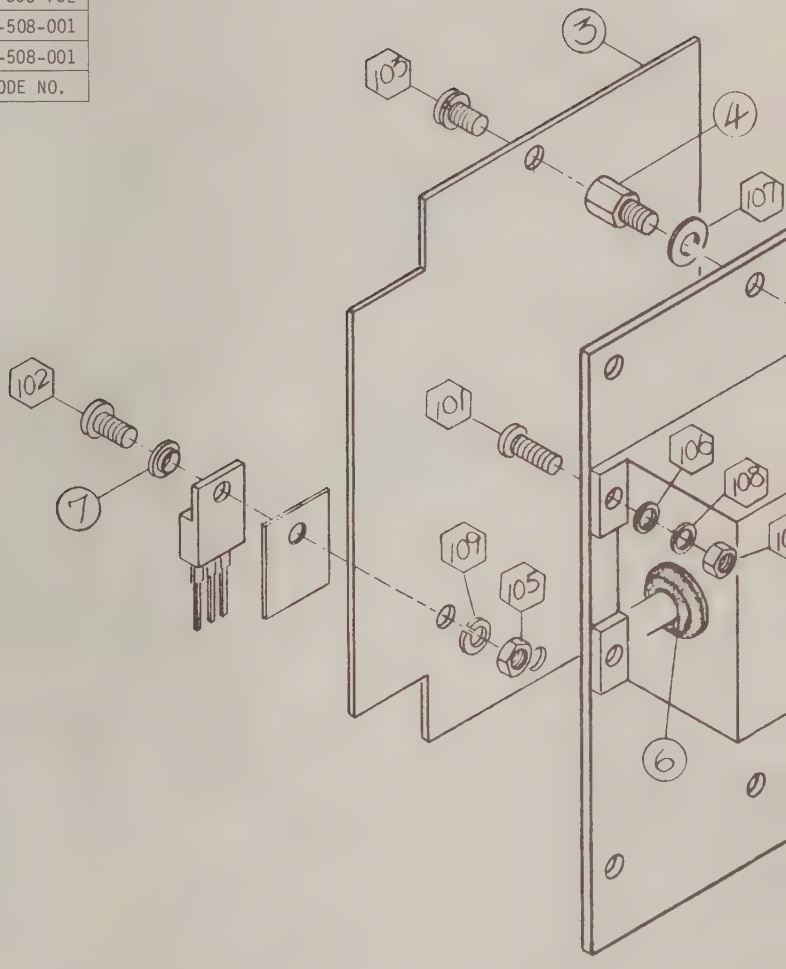
4	SHAFT FOR POWER SW	1	Q5-506-701
3	JOINT UJ3.2-3.2	1	P4-000-751
2	EXTENSION SHAFT	1	K4-506-701
1	BRACKET FOR INTEN-VR	1	D3-506-708
NO.	NAME	QTY	CODE NO.



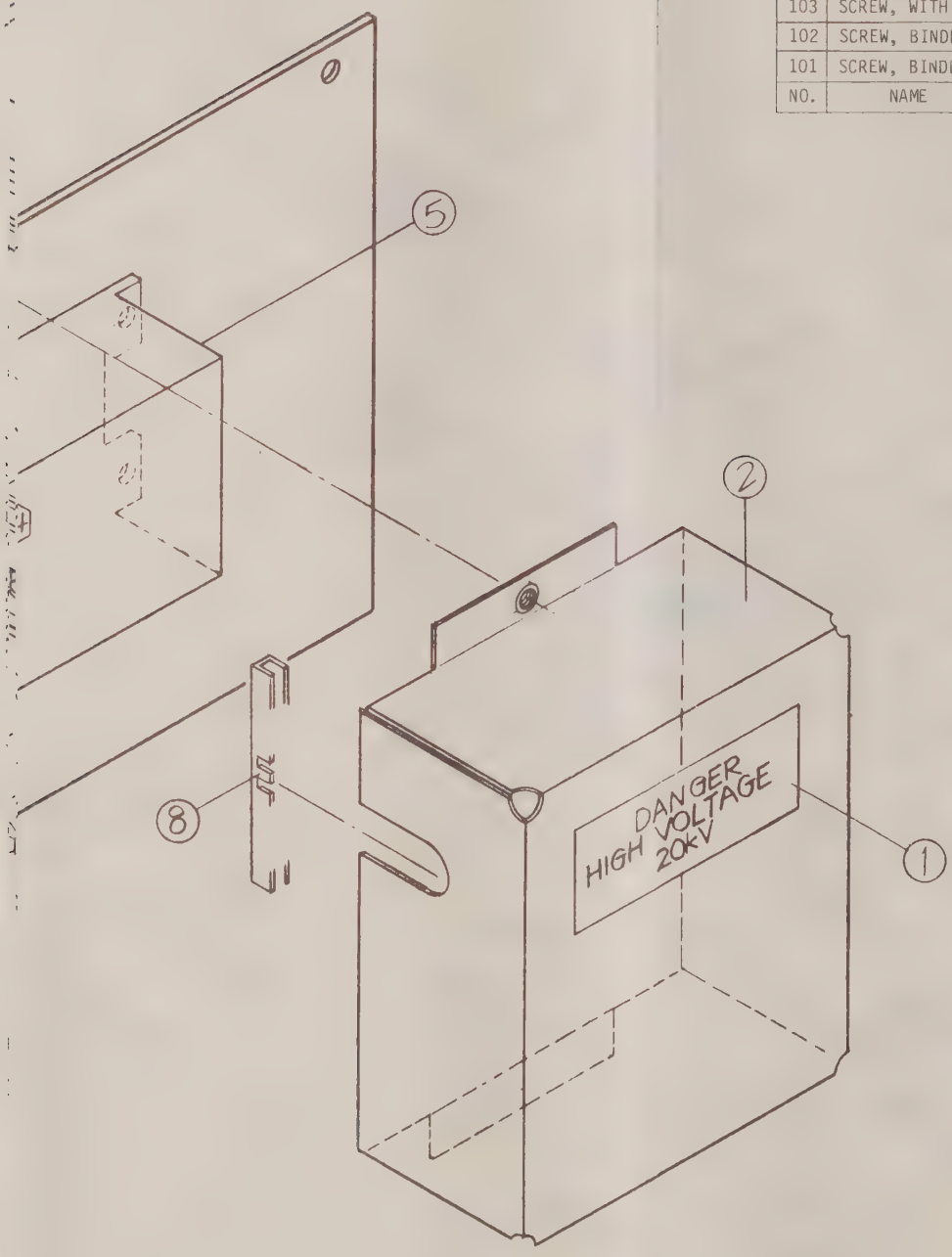
NO.	NAME	QTY	CODE NO.
101	SCREW, WITH SW, PW M3x6	2	M3-002-011



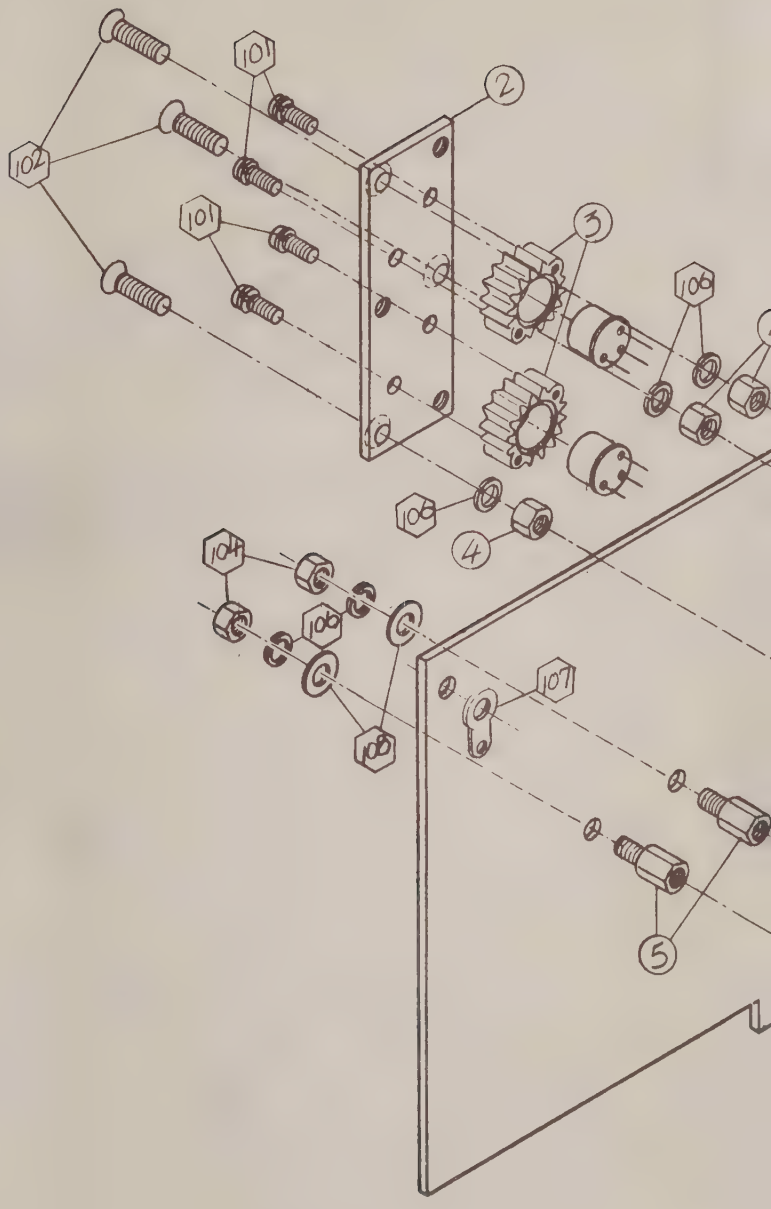
8	BUSHING, FLEXIBLE KG-016	45mm	P4-000-051
7	B-17 BUSHING	1	Q2-000-231
6	BUSHING RUBBER BU-687 EX.S	1	P4-000-781
5	H·V UNIT CASE	1	P1-050-041
4	SPACER HEXAGON 3-6	2	L3-021-011
3	SHIELD PLATE FOR DD-CON	1	C9-506-702
2	SHIELD BOX FOR D-D CON	1	C8-508-001
1	SEAL (DANGER)	1	A8-508-001
NO.	NAME	QTY	CODE NO.



NO.	NAME	QTY	CODE NO.
109	M3SW	1	M5-001-031
108	M2.6SW	4	M5-001-021
107	M3PW	2	M5-000-031
106	M2.6PW Ⓚ	4	M5-000-022
105	M3N 3SHU	1	M4-000-081
104	M2.6N	4	M4-000-021
103	SCREW, WITH SW M3x6	2	M3-001-011
102	SCREW, BINDER HEAD M3x6	1	M2-000-391
101	SCREW, BINDER HEAD M2.6x8	4	M2-000-051



HIGH VOLTAGE POWER ASSEMBLY 319628


101
2
102
101
3
106
108
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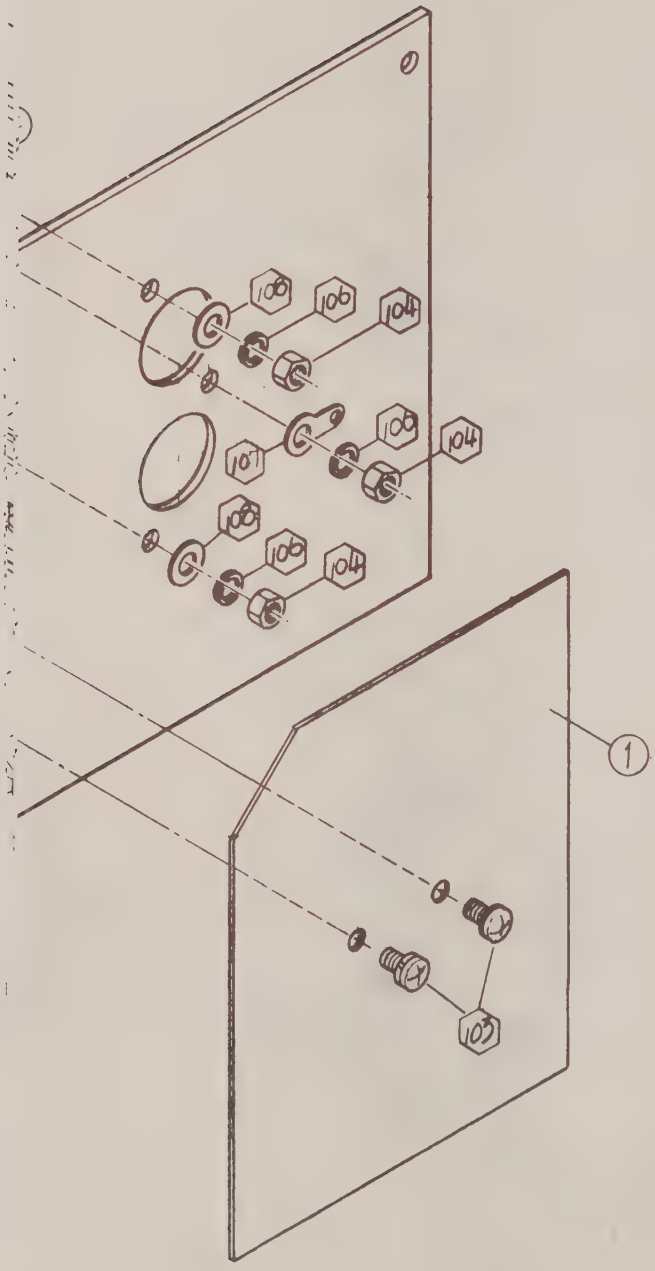
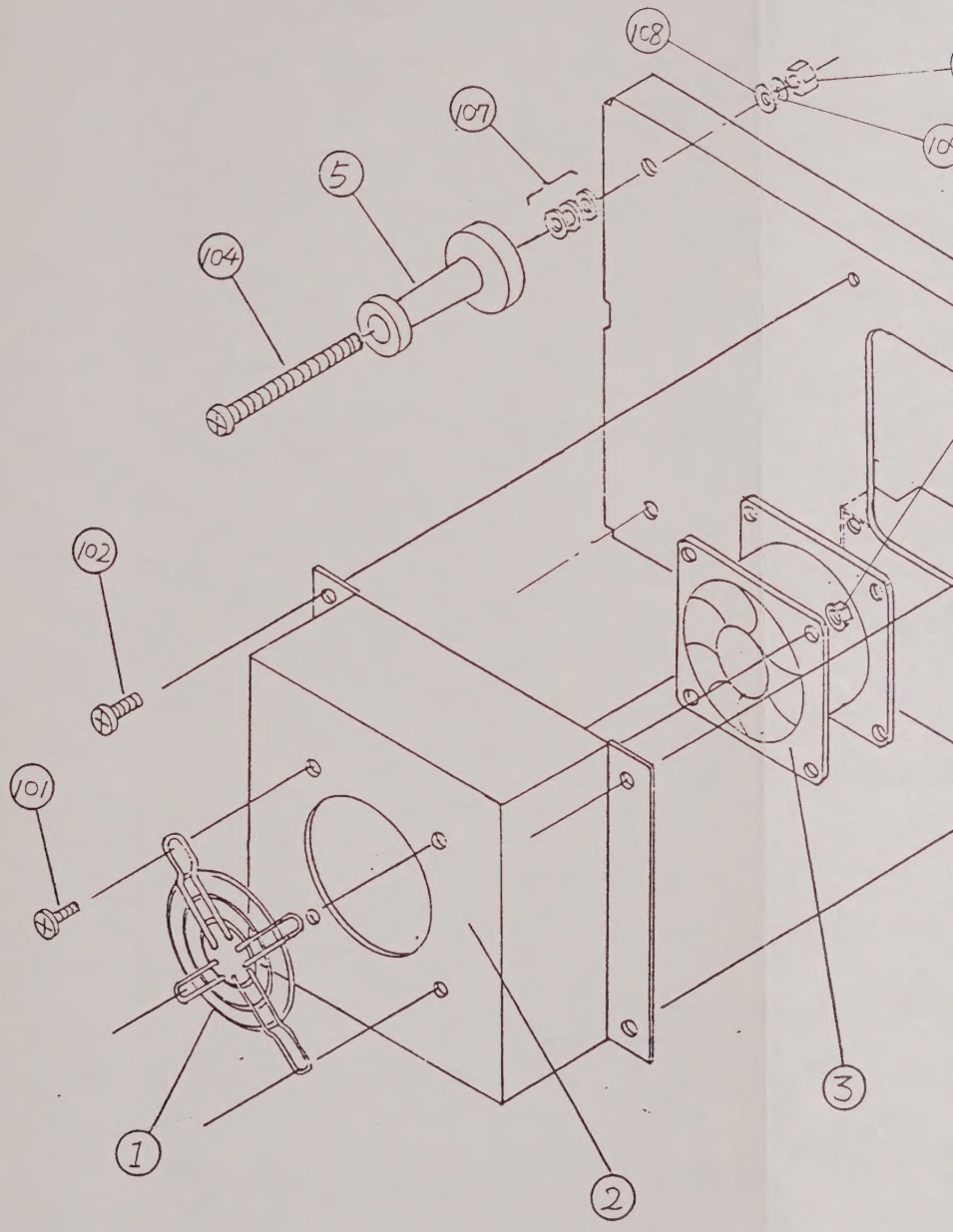
104
106
107
106
5

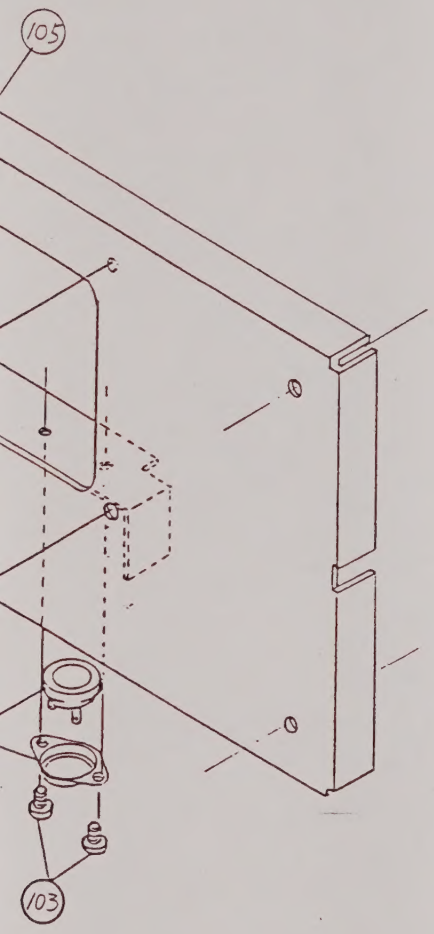


108	M3PW	4	M5-000-031
107	M3ET-LUG	2	M6-000-021
106	M3SW	8	M5-001-031
105	-	-	-
104	M3N	5	M4-000-031
103	SCREW WITH SW M3x6	2	M3-001-011
102	SCREW, FLAT HEAD M3x14	3	M2-001-521
101	SCREW WITH SW M2x6	4	M3-001-141
NO.	NAME	QTY	CODE NO.

5	SPACER HEX 3-7	2	L3-070-031
4	SPACER HEX 3-4	3	L3-020-181
3	HEAT SINK NZ5C	2	H2-000-211
2	HEAT SINK FOR VERT TR	1	H1-506-703
1	HOLDER DL-LINE	1	D3-508-503
NO.	NAME	QTY	CODE NO.

VERTICAL FINAL ASSEMBLY 320540


108
107
5
104
102
101
1
2
3



Item	Part No.	Qty	Name & Discription
1	QJ-13-7105	1	FINGER GUARD PG-24
2	QJ-13-7120	1	COVER FOR FAN COS6150S
3	QJ-13-7122	1	FAN
4	82-91-0290	1	5003 TYPE K THERMOSTAT
5	P2-000-271	1	HOLDER CORD 5650
Item	Part No.	Qty	Name & Discription
101	M2-000-091	4	BIND M3×8 B-Ni
102	M2-000-391	4	BIND M3×6 B-Ni
103	M2-000-391	2	BIND M3×6 B-Ni
104	M2-000-541	4	NABE M4×50 B-Ni
105	M4-000-033	4	M3FN
106	M4-000-041	4	M4N B-Ni
107	M5-000-041	12	M4PW B-Ni
108	M5-000-041	4	M4PW B-Ni
109	M5-001-041	4	M4SW B-Ni

LIMITED WARRANTY

All instruments sold by KIKUSUI INTERNATIONAL CORPORATION are warranted to the original purchaser against defects in materials and workmanship from the date of original shipment to the purchaser within the following time limits:

Oscilloscope	—	2 year limited warranty
Power Supply	—	5 year limited warranty
Test Instrument	—	1 year limited warranty

However, this warranty excludes accessories, batteries, lead wires, and probes. Also, this warranty does not apply to any instruments determined by KIKUSUI INTERNATIONAL CORPORATION to have been subjected to customer alteration, modification, negligence or misuse.

In the event of any defects determined by KIKUSUI INTERNATIONAL CORPORATION to be covered by this warranty, KIKUSUI INTERNATIONAL CORPORATION will, at its sole option, repair or replace the defective instrument without charge and at its expense reship anywhere in the United States. To obtain warranty service, the defective instrument must be returned within thirty (30) days after the expiration of the applicable warranty period to KIKUSUI INTERNATIONAL CORPORATION or an Authorized Warranty Repair Station, properly packaged and with transportation and insurance prepaid. This warranty is valid only in the United States of America. Any customers of KIKUSUI INTERNATIONAL CORPORATION located outside of the United States should check with their nearest Authorized Agent for warranty information applicable to them.

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